CAIS STANDARD MANUAL

SYSTEM NO. 16
BRIDGES

CAS PROJECT
CAIS MANUAL

Issued April 28, 1995

8 Mar 96

MEMORANDUM FOR DTIC-OCP
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FROM: AL/EQ (STINFO)
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SUBJECT: Transmision of Technical Documents

1. As per telephone conversation with Andrew Poulis, EQ/TIC, the attached CAIS CTDS manuals are forwarded for accession, cataloging, and microconversions. Please forward the accession numbers to:

Andrew Poulis
AL/EQ/TIC
139 Barnes Drive. Suite 2
Tyndall AFB, FL 32403-5323

2. The Distribution statement should read as follows: Approved for Public Release: Distribution Unlimited.

3. If you have questions about these documents, please contact Andrew Poulis at DSN 523-6285.

Larry L. Testerman
LARRY L. TESTERMAN
Scientific and Technical
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Atchs: Manuals

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ABSTRACT

GENERAL ORGANIZATION

At this installation the list of facilities to be surveyed, including infrastructure, will be addressed on the basis of 32 unique systems that form the CAIS Engineering Deficiency Standards and Inspection Methods document. Each system deals with a specific technical aspect of the facility to be surveyed. Within each system a further breakdown is made to subsystems, each having a related list of components. Detailed observations of the listed defects are provided so as to allow the entry of observed quantification data. A DOD CAIS manual is provided for each of the 32 systems with an internal organization as outlined below:

INSPECTOR'S GUIDE

I. General
   - A. Level I Inspection Method Description
   - B. Level II Inspection Method Description
   - C. Level III Inspection Method Description

II. General Inspection
   - A. Process. This section describes the process of the inspection activity.
   - B. Location. This section describes the procedure for locating the inspection units in the facility or infrastructure on this installation.

III. Inspector Qualifications
   This section notes the minimum qualifications for the person or persons performing the survey.

IV. Inspection Unit
   This section describes how the IU (Inspection Unit) is determined for the particular component being surveyed.

V. Unit Costs
   This section notes the nature of repair costs for this system.

VI. Standard Safety Requirements
   This section lists safety procedures and equipment required to implement a safe environment for the conduct of this survey.

VII. Standard Tools
   This section lists a set of standard tools required for the general conduct of this survey.

VIII. Special Tools and Equipment Requirements
   This section refers to special tools or equipment requirements endemic to the nature of the system being surveyed.

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IX. Level II Inspection Method Keys

This section explains the use of keys as they relate to Level II Guide Sheets.

X. Level III Inspection Method Keys

This section explains the use of keys as they relate to Level III Guide Sheets.

XI. Replacement Cost

This section describes the nature and location of replacement cost data.

XII. Appendices

Appendix A. Provides a listing and definition of all abbreviations used both in the Standards and in the data base.

Appendix B. Provides a glossary of terms with their definitions as used in the Standard.

Appendix C. This section contains a listing of the average life cycle durations for each assembly* in the Standard.

* Assembly is a term describing the level at which replacement rather than repair occurs. This can be at the subsystem or component designation, depending on the system being surveyed.

SYSTEM TREE

The System Tree is a graphical representation of the Work Breakdown Structure, showing system, subsystem and component relationships for the Bridges System.

INSPECTION METHODS

Description

Describes the nature of what is to be condition surveyed.

Special Tool and Equipment Requirements

Lists any special tools required for this specific subsystem.

Special Safety Requirements

This section outlines any special safety measures or equipment required for this specific subsystem so as to maintain a safe environment and process in the conduct of the condition survey.

Component List

All components to be surveyed under this subsystem are listed here.

Related Subsystems

All other subsystems that have a survey relationship to this subsystem are listed here to help coordinate a complete and thorough condition assessment survey.

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Standard Inspection Procedure

This statement indicates the various levels of survey effort required for this subsystem.

Components

The previously listed components of this subsystem are described with a survey procedure recommended on a component by component basis. For each component there is a listing of defects with each defect broken down into observations describing the nature and severity of the defective condition observed. The surveyor enters a quantification value for each defect/observation encountered in the field CAIS device (DCD) to record the result of his survey.

References

This page lists the reference sources from which the foregoing subsystem data was developed.

Guide Sheet Control Number

This section lists the key numbers that tie the written Level II and Level III guide sheets to specific components in this subsystem.

Level II and Level III Inspection Method Guide Sheets

This section contains the detailed descriptions of the Level II and III survey and inspection procedures for this subsystem.

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INSPECTOR'S GUIDE

I. GENERAL

A. Level I Inspection Method

The purpose of the Level I Inspection Method is to detect observable defects in a bridge structure. A bridge is an active structure, subject to repeated loading, erosion, corrosion, and deterioration by wind, water, ice and temperature. A well documented inspection will observe these deteriorations and identify needed repairs that, if carried out, can prevent structural failure and provide full life cycle usage of the bridge.

The Level I Inspection Method for a bridge structure consists of an inspection of the readily accessible parts of the bridge as described in the Work Breakdown Structure (WBS). The Level I Inspection Method is a walk-by inspection while taking measurements. The standard inspection is designed to be performed by two inspector.

Depending on the bridge type, a boat may be required to observe certain components above the waterline. The level I inspection method is essentially a general inspection "swim-by" overview. The inspection can detect obvious major damage or deterioration due to collision, corrosion, or biological growth and attack. The "swim-by" inspection relies primarily on and / or tactile observations (depending on the water clarity to make condition assessments). Minimum of 3 persons are required for a Level I "swim-by" inspection.

The observations recorded by the inspector during a Level I inspection are designed to create a historical data base for the continued design life of the structure, to highlight particular items which require inspection by a qualified engineer experienced in the design and construction of bridge structure (whichever is appropriate), and to devise maintenance and repair strategy.

B. Level II Inspection Method

A Level II Inspection Method is performed to obtain additional information or measurements concerning a defect observed during the course of the Level I inspection process. In all instances, the Level II Inspection Method is additional work performed by the inspector during performance of the Level I inspection.

C. Level III Inspection Method

Level III inspections should be conducted by an engineer or team of engineers experienced in the design and construction of bridge structure and should include a thorough systematic evaluation of the condition triggering the Level III inspection and an assessment of the safety and stability of the bridge structure.

Level III inspections should be performed when triggered by conditions observed during a Level I or Level II inspection or on a regularly scheduled basis, whichever occurs first (see Facility Manager Guide). In addition, Level III inspections should also be performed where inspection of appurtenant work components require difficult access

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methods to be used or when work to be performed by others is required prior to gaining access for the inspection.

Depending on the assessment of the potential impact of observed conditions on the safety or stability of the bridge, advanced test and inspection methods may be required as part of the Level III inspection to determine the cause and/or extent of an observed defect.

Level III underwater inspection must be accomplished by a certified diver(s).

II. GENERAL INSPECTION

A. Process

The Level I inspection shall be carried out for each component listed in the WBS for bridges. Potential defects have been identified along with relevant observations, allowing the inspector to prepare a record of observable conditions at the bridge site. The inspector will identify the defect, record the observation, and take measurements as necessary to record the quantity or extent of the defect. No attempt will be made to officially assess the safety of the bridge structure during this inspection. The observation of certain defects will automatically trigger a Level III inspection to be performed in order to confirm the severity of the observed defect and to assess the safety of the bridge.

Level I and Level II inspections are to be performed with one or more personnel accompanying the inspector at the bridge site as specifically recommended in these documents.

B. Location

Level I and II inspection will be located by the inspector through a discrete entry into the data Collection Device. The "IU" or component location will be derived from facility supplied segment numbering lists, maps or other I.D. numbering systems. For Building associated "IU's" and components the Facility shall furnish plans annotated with room number schedules. In the case of non-room associated components, plans will be orientated with the top of each sheet being the north direction, so as to allow direction location and description. In the case where no maps, or plans are available the inspector shall enter a brief (65 character), description of location.

III. INSPECTOR QUALIFICATIONS

The personnel performing standard inspections of a bridge should be a journeyman and have a minimum of 5 years experience in inspection of bridge structure. Inspectors shall be trained in the CAS system and its operation and shall be CAS certified.

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IV. INSPECTION UNIT (IU)

The IU is normally defined at the subsystem level. Components have been identified for the bridge subsystem which are to be inspected where applicable. In order to create a historical data base for the structure, there is also opportunity at the component level to identify the location and order of magnitude of the observed defect. Occasionally the IU will occur at the component level. In those cases it will be noted in the subsystem description.

V. UNIT COSTS

The unit costs that are applied to the quantities recorded for each observation are contained within the Site CAIS as repair cost.

VI. STANDARD SAFETY REQUIREMENTS

Prior to inspection of the bridge, the authority (Facility Manager) having jurisdiction shall be notified to secure proper access, safety briefings, and personal safety items. See Master Safety Plan for additional requirements.

VII. STANDARD TOOLS

Employee Identification Card - to be worn or carried during all inspections
Data Collection Device (DCD)
Battery pack for DCD
100 ft tape measure
Measuring wheel
Camera: 35 mm
Calipers
Marking paint
Binoculars
Flashlight
Flat blade screwdriver
Wire brush
Hammer
Ice pick

VIII. SPECIAL TOOLS AND EQUIPMENT REQUIREMENTS

At the component level, no special tools and equipment are required for the Level I inspection of the associated components. Level III Guide Sheets will address additional tools and equipment requirements that are specific to that particular method. Inspectors should review these sections in order to determine any special tool requirements for components they are to inspect.

IX. LEVEL II INSPECTION METHOD KEYS

Certain defect observations or the designated inspection of certain components will trigger a Level II inspection. The Facility Manager will be able to identify defects where a Level II inspection is flagged. The Level II key at the observation level will refer to a specific guide sheet.

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X. LEVEL III INSPECTION METHOD KEYS

Certain observations will trigger a Level III inspection. The Level III key at the observation level will refer to a specific guide sheet. The Facility Manager will be able to identify deficiencies where a Level III inspection is flagged. These guide sheets, will identify the Level III inspection may refer the Facility Manager to a more sophisticated inspection method.

XI. REPLACEMENT COST

A replacement cost for each subsystem will be contained within the cost estimating system in the Site CAIS. Remedial measure costs to correct observed defects will be estimated by the engineer(s) subsequent to the results of a Level III inspection.

XII. APPENDICES

Appendix A - Abbreviations

A summary and definition of all abbreviations used in this system are contained in Appendix A which is located at the end of Bridges.

Appendix B - Glossary

A glossary of terms used in this system are contained in Appendix B which is located at the end of Bridges.

Appendix C - Life Cycles

A listing of the average life cycle durations for each assembly* in the Standard.

Note - Facility Manager's Guide

The following are included in the Facility Manager's Guide:

A table showing the required manhours to perform the standard inspection for this facility listed by Cat Code (three digit).

A listing of all Level III inspections with their estimated cost and time to perform. This list will include frequency of inspection for time driven Level III's.

* Assembly is a term describing the level at which replacement rather than repair occurs. This can be at the subsystem or component designation, depending on the system being surveyed.

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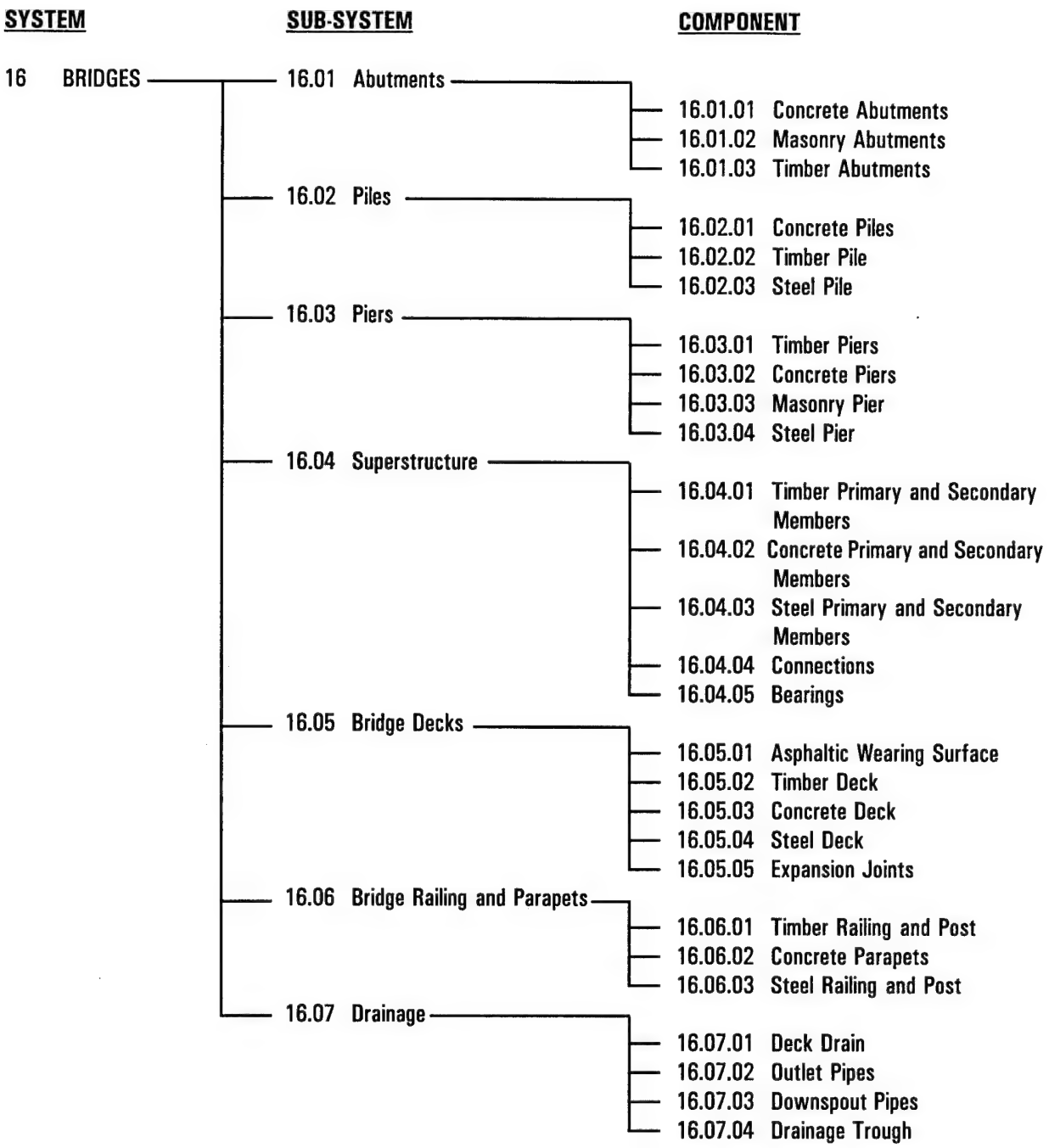
Figure 16-A. WORK BREAKDOWN STRUCTURE



16.01 ABUTMENTS

DESCRIPTION

An abutment is a substructure unit located at the end of a bridge. Its function is to provide end support for the bridge and to retain the approach embankment. Abutments are classified according to their location with respect to the approach embankment. The most common abutment types are; full height or closed types and open or spill-through type. The primary material used in the construction are plain cement concrete, reinforced concrete, stone masonry, timber or a combination of these materials. Plain Concrete and stone masonry abutments are usually gravity structures while reinforced concrete abutments are mostly cantilever or counterfort types.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the Standard Tool Section, may be required to perform the inspection of this subsystem.

1. Boat
2. Related safety equipment

SPECIAL SAFETY REQUIREMENTS

Level I and Level II inspections are performed by walking the perimeter of the bridge abutment and observing defects from ground level thus passing traffic is a hazard. The inspection must be performed with prior approval of the Facility Manager, who will notify the necessary authorities so as to provide traffic safety measures and access. It is suggested that the inspector wear an orange safety vest.

Depending on the bridge type a boat may be required to observe certain components. The inspectors are required to take all necessary safety measures. Refer to the Master Safety Plan for guidance and compliance.

COMPONENT LIST

- 16.01.01 CONCRETE ABUTMENT
- 16.01.02 MASONRY ABUTMENT
- 16.01.03 TIMBER ABUTMENT

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

13.02	RETAINING WALLS
19.01	ROADWAYS
20.01	RAILROAD
21.00	WATERFRONT (all subsystems)
29.00	SITE ELECTRICAL (all subsystems)

16.01 ABUTMENTS

STANDARD INSPECTION PROCEDURE

The Level I inspection shall be carried out for each component listed. The inspector will identify any physical defects existing in each component; will note the level of severity of each defect type; and measure the quantity of each defect. All observed defect/observation data will be entered by the inspector into the Data Collection Device.

COMPONENTS

◆ 16.01.01 CONCRETE ABUTMENT

The primary abutment elements are: bridge seat, back wall, breast wall and wingwalls. The bridge seat provide a bearing area which supports the bridge superstructure. The backwall is the topmost portion of an abutment. Its primary function is to retain the soil and keep it from sliding onto the bridge seat and provide support for the approach slab. The breast wall supports the superstructure live and dead loads and retains the approach fill. The breast wall also consolidates and transmits the loads to the footings or piles. Wingwalls are the walls on each side of an abutment which enclose the approach.

Potential defects which may be observed include drainage, scour or erosion, vertical, lateral and rotational movement of the abutment due to instability of the soil and deterioration of the concrete surfaces.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Drains or Weep Holes:**			
Observation:			
a. Drains and weep hole clogged.	EA		
***{Severity L}			
b. Signs of water stain on the face of abutment around cracks.	LF		
***{Severity M}			
c. Visible signs of water seeping through cracks or joints in the abutment.	LF		
***{Severity H}			
Defect:			
*** Erosion or Scouring at Abutment or Wingwalls:**			
Observation:			
a. Voids less than 2".	SF		
***{Severity L}			
b. Voids greater than 2" less than 6".	SF		
***{Severity H}			
c. Undermining of abutment, with voids greater than 6".	SF		1
***{Severity H}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ **16.01.01 CONCRETE ABUTMENT (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Horizontal Cracks:**			
Observation:			
a. Hairline cracks less than 1/16" wide.	LF		
***{Severity L}			
b. Medium crack greater than 1/16" less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	1	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposit, spalling of cracks, and reinforcing bars exposed.	LF		1
***{Severity H}			
Defect:			
*** Diagonal Cracks - Breastwall/wingwalls:**			
Observation:			
a. Hairline cracks less than 1/16" wide.	LF		
***{Severity L}			
b. Medium crack greater than 1/16" less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	1	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposit, spalling of cracks, and reinforcing bars exposed.	LF		1
***{Severity H}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ 16.01.01 CONCRETE ABUTMENT (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Vertical Cracks:**			
Observation:			
a. Hairline cracks less than 1/16" wide	LF		
***{Severity L}			
b. Medium crack greater than 1/16" less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	1	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposit, spalling of cracks, and reinforcing bars exposed.	LF		1
***{Severity H}			
Defect:			
*** Joints - Backwall and Wingwalls:**			
Observation:			
a. Joint separation or movement less than 1/8".	LF		
***{Severity L}			
b. Joint separation or movement greater than 1/8" less than 1/4".	LF		
***{Severity M}			
c. Joint separation or movement greater than 1/4".	LF		1
***{Severity H}			
Defect:			
*** Scaling:**			
Observation:			
a. Loss of surface mortar greater than 1/4" deep and less than 1/2" deep with exposed aggregate.	SF		
***{Severity L}			
b. Loss of surface mortar greater than 1/2 " deep, less than 1" deep. Coarse aggregates are clearly exposed.	SF		
***{Severity M}			
c. Loss of coarse aggregate particles, as well as mortar surrounding coarse aggregates; depth of the loss greater than 1" deep, reinforcing bars exposed.	SF		1
***{Severity H}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ 16.01.01 CONCRETE ABUTMENT (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Rotational Movement:** Some abutments are constructed with battered or slope front face.			
Observation:			
a. Abutment walls rotated inward or outward. ***{Severity H}	LF		1
b. Wing walls rotated inward or outward. ***{Severity H}	LF		1
Defect:			
*** Bearing Seat - Breast Wall:** (Critical where beam bears directly on the Abutment wall.)			
Observation:			
a. Light spalling and chipping of concrete. ***{Severity L}	SF		
b. Dirt and debris accumulated on bearing seat. ***{Severity L}	SF		
c. Spalling, cracking of concrete at edge of seat. ***{Severity M}	SF		
d. Severe spalling and cracking with crushing of concrete and exposed reinforcing bars. ***{Severity H}	SF		1
Defect:			
*** Vehicular Damage:**			
Observation:			
a. Member out-of-alignment. ***{Severity H}	SF		
b. Member cracked, crushed or missing. ***{Severity H}	SF		

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ **16.01.01 CONCRETE ABUTMENT (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Spalling:**			
Observation:			
a. Depression less than 1" deep and less than 6" in diameter.	SF		
***{Severity L}			
b. Depression greater than 1" deep and greater than 6" in diameter.	SF	1	
***{Severity M}			
c. Depression greater than 1" deep and greater than 6" in diameter with corroded re-bars.	SF		1
***{Severity H}			
Defect:			
*** Popout:**			
Observation:			
a. Conical shape holes less than 1/2" diameter.	SF		
***{Severity L}			
b. Conical shape Hole greater than 1/2" less than 2 1/2 inch diameter.	SF		
***{Severity M}			
c. Conical shape hole greater than 2-1/2" in diameter.	SF		
***{Severity M}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ 16.01.02 MASONRY ABUTMENT

The primary elements of a masonry abutment are bridge seat, stem wall or breastwall, wingwalls and footing. The bridge seat provides a bearing area which supports the bridge superstructure. The stem or breast wall supports the superstructure live and dead loads and retains the approach fill. The stem or breast wall also consolidates and transmits the loads to the footing. Wingwalls are the walls on each side of an abutment which enclose the approach.

Potential defects which may be observed include drainage, scour or erosion, vertical, lateral and rotational movement of the abutment due to instability of the soil and deterioration of the masonry surfaces.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Drains or Weep Holes:**			
Observation:			
a. Drains and weep hole clogged.	EA		
***{Severity L}			
b. Signs of water stain on the face of abutment with vegetation growth at joints.	LF		
***{Severity M}			
c. Visible signs of water seeping through cracks or joints in the abutment.	LF		
***{Severity H}			
Defect:			
*** Erosion or Scouring at Abutment or Wingwalls:**			
Observation:			
a. Voids less than 2".	SF		
***{Severity L}			
b. Voids greater than 2", less than 6".	SF		
***{Severity H}			
c. Undermining of abutment, with voids greater than 6".	SF		2
***{Severity H}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ **16.01.02 MASONRY ABUTMENT (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Mortar Joint:**			
Observation:			
a. Mortar joint cracked with no voids masonry stone sound.	SF		
***{Severity L}			
b. Mortar joint deteriorated with voids, vegetation growing from joint, stone loose.	SF		
***{severity M}			
c. Mortar joint totally deteriorated, masonry stone missing.	SF		2
***{Severity H}			
Defect:			
*** Masonry Stone Deterioration:**			
Observation:			
a. Masonry stone, minor spalling and hairline cracks.	SF		
***{Severity L}			
b. Masonry stone, spalling with cracks and chipping, stone loose.	SF		
***{Severity M}			
c. Masonry stone, spalling with large cracks and chipping, section loss greater than 15%.	SF		2
***{Severity H}			
Defect:			
*** Joints - Abutment and Wingwalls:**			
Observation:			
a. Joint separation or movement less than 1/2".	LF		
***{Severity L}			
b. Joint separation or movement greater 1/2" less than 1".	LF		
***{Severity M}			
c. Joint separation or movement greater than 1".	LF		2
***{Severity H}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ **16.01.02 MASONRY ABUTMENT (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Vehicular Damage:**			
Observation:			
a. Member out-of-alignment.	SF		2
***{Severity H}			
b. Member cracked, crushed or missing.	SF		2
***{Severity H}			
Defect:			
*** Rotational Movement:**			
Observation:			
a. Abutment walls rotated inward or outward.	LF		2
***{Severity H}			
b. Wing walls rotated inward or outward.	LF		2
***{Severity H}			
Defect:			
*** Bearing Seat:**			
(Critical where beam bears directly on the Abutment wall.)			
Observation:			
a. Light spalling and chipping of masonry.	SF		
***{Severity L}			
b. Dirt and debris accumulated on bearing seat.	SF		
***{Severity L}			
c. Spalling, cracking of masonry at edge of seat.	SF		
***{Severity M}			
d. Severe spalling and cracking with crushing of masonry.	SF		2
***{Severity H}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ 16.01.03 TIMBER ABUTMENT

The primary elements of a timber abutment are bridge seat, stem wall or breastwall, wingwalls, footing and piles. The bridge seat provides a bearing area which supports the bridge superstructure. The stem or breast wall supports the superstructure live and dead loads and retains the approach fill. The stem or breast wall also consolidates and transmits the loads to the footing. Piles are often used to provide lateral support for stem or breast wall and support for the superstructure. Wingwalls are the walls on each side of an abutment which enclose the approach.

The potential defects which may be observed include scour or erosion, vertical, lateral and rotational movement due to soil instability and deterioration to timber members.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Bearing Seat:**			
Observation:			
a. Moist and stained, surface solid.	SF		
***{Severity L}			
b. Dirt and debris accumulated on bearing seat.	SF		
***{Severity L}			
c. Moist and stained, surface soft, slight crushing.	SF	2	
***{Severity M}			
d. Area soft and crumbly and seriously deteriorated.	SF		3
***{Severity H}			
Defect:			
*** Erosion or Scouring at Abutment or Wingwalls:**			
Observation:			
a. Voids less than 2".	SF		
***{Severity L}			
b. Voids greater than 2" less than 6".	SF		
***{Severity H}			
c. Undermining of abutment, with voids greater than 6".	SF		3
***{Severity H}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ **16.01.03 TIMBER ABUTMENT (Continued):**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Decay - Breast/Wingwalls:** Decay from rot/fungus is most likely to occur at connections, splices, support points or around bolt holes. This may be due either to the tendency of such area to collect and retain moisture,or to bolts holes or cuts being made in the surface after the preservative treatment has been applied.			
Observation:			
a. Moist and stain or discolored area, signs of fungi, surface is solid.	SF		
***{Severity L}			
b. Surface spongy, member may shown signs of crushing.	SF	2	
***{Severity M}			
c. Brown and white - discolored area, member may show section loss and crushing.	SF		3
***{Severity H}			

Defect:

*** Parasites - Breast/Wingwalls and Pile Lagging:**
(Termites, carpenter ants, powder post beetles)

Observation:			
a. Pinholes with dark stain area around the holes.	SF		
***{Severity L}			
b. Holes less than 1/8" dia., surface sag, and sawdust observed.	SF	2	
***(Severity M}			
c. Holes greater than 1/8" dia., surface channels, and crushing of the member.	SF		3
***{Severity H}			

16.01 ABUTMENTS

COMPONENTS (Continued)

◆ **16.01.03 TIMBER ABUTMENT (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Rotational Movement - Breast Wall/Wingwalls:**			
Observation:			
a. Breast wall rotated inward or outward.	EA		3
***{Severity H}			
b. Wing wall rotated inward or outward.	EA		3
***{Severity H}			
Defect:			
*** Weathering:**			
Observation:			
a. Surface of wood is rough and corrugated and member may be warped.	SF		
***{Severity L}			
b. Surface of wood is rough and corrugated with cracks partially through the wood member, may have minor section loss. Member may be warped.	SF	2	
***{Severity M}			
c.Large cracks extends deeply or completely through the wood.	SF		3
***{Severity H}			
d. Wood is crumbly and seriously deteriorated.	SF		3
***{Severity H}			
Defect:			
*** Vehicular Damage:**			
Observation:			
a. Member out-of-alignment.	SF		3
***{Severity H}			
b. Member cracked, crushed or missing.	SF		3
***{Severity H}			

16.01 ABUTMENTS

REFERENCES

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition.

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.01 ABUTMENTS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 16.01.01-1
2	GS-II 16.01.02-2

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 16.01.01-1
2	GS-III 16.01.02-2
3	GS-III 16.01.03-3

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: CONCRETE ABUTMENT
CONTROL NUMBER: GS-II 16.01.01-1

Application

This applies to the investigation of concrete bridge abutment deterioration due to spalling from delamination. The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the level II.

Inspection Actions

1. Clean loose concrete from area to be inspected.
2. Measure the affected area.
3. Tap the affected area with a hammer to determine extent of unsound or hollow concrete.

Recommended Inspection Frequency

When triggered by Level I inspection and where Level II is utilized as the standard inspection procedure.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public Roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete
5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: TIMBER ABUTMENT
CONTROL NUMBER: GS-II 16.01.02-2

Application

This applies to the investigation of possible interior and exterior deterioration of timber abutment due to decay (rot), or parasites.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the Level II.

Inspection Actions

1. Clean affected area.
2. Measure affected area.
3. Tap with hammer to determine extend of hollow or sound material.
4. Probe with ice pick.

Recommended inspection Frequency

When triggered by Level I inspection and where Level II is utilized as the standard inspection procedure.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public Roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: CONCRETE ABUTMENTS
CONTROL NUMBER: GS-III 16.01.01-1

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a concrete abutment.

Whereas the purpose of the Level I inspection was to record the observable defects at the abutments, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the abutment and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the concrete abutments.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CONCRETE ABUTMENTS
CONTROL NUMBER: GS-III 16.01.01-1

Inspection Actions

1. Prior to making a field inspection of the observed defect, review all past records concerning the abutments and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level record and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the abutment.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CONCRETE ABUTMENTS
CONTROL NUMBER: GS-III 16.01.01-1

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for concrete abutments include, but are not limited to the following:

Advanced Test or Inspection Method	Applicable Observed Defects
1. Infrared Thermography and Ground probing radar	concrete deterioration, cracks and spalling
2. Concrete coring	concrete deterioration
3. Laboratory tests on concrete (core, strength tests, abrasion, absorption,sulfate soundness, unit weight	concrete deterioration
4. Ultrasonic test	cracks and voids in concrete
5. Half-cell test	corrosion to reinforcement steel
6. Soil borings	soil instability and settlement
7. Laboratory tests on soil samples (strength tests, moisture content, consolidation tests, etc.)	soil instability
8. Underwater Inspection	erosion, scouring and undermining
9. Survey measurement	abutment movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Surveying equipment
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CONCRETE ABUTMENTS
CONTROL NUMBER: GS-III 16.01.01-1

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: MASONRY ABUTMENTS
CONTROL NUMBER: GS-III 16.01.02-2

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a masonry abutment.

Whereas the purpose of the Level I inspection was to record the observable defects at the abutments, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the abutment and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the abutments.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: MASONRY ABUTMENTS
CONTROL NUMBER: GS-III 16.01.02-2

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the abutments and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the abutment.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for abutments include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: MASONRY ABUTMENTS
CONTROL NUMBER: GS-III 16.01.02-2

Advanced Test or Inspection Method	Applicable Observed Defects
1. Infrared Thermography and ground probing radar	masonry deterioration, cracking and spalling
2. Ultrasonic test	cracks and voids in masonry
3. soil borings	soil instability, erosion and settlement
4. laboratory tests on soil samples (strength tests, moisture content, consolidation tests, etc.)	soil instability
5. Underwater Inspection	erosion, scouring and undermining
6. Survey measurement	abutment movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Equipment designated in Level I inspections
Surveying equipment
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I and II defect/Observations or every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: MASONRY ABUTMENTS
CONTROL NUMBER: GS-III 16.01.02-2

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: TIMBER ABUTMENTS
CONTROL NUMBER: GS-III 16.01.03-3

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a timber abutment.

Whereas the purpose of the Level I inspection was to record the observable defects at the abutments, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the abutment and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the abutments.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: TIMBER ABUTMENTS
CONTROL NUMBER: GS-III 16.01.03-3

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the abutments and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the abutment.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for abutments include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: TIMBER ABUTMENTS
CONTROL NUMBER: GS-III 16.01.03-3

Advanced Test or Inspection Method	Applicable Observed Defects
1. Increment borer	interior and exterior deterioration of timber due to decay or parasites
2. Ultrasonic	interior voids due decay or parasites
3. Moisture content	deterioration due to decay or parasites
4. Soil borings	soil instability, erosion
5. Laboratory tests on soil samples (strength tests, moisture content, consolidation tests, etc.)	soil instability
6. Underwater Inspection	erosion, scouring and undermining
7. Survey measurement	abutment movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Equipment designated in Level I inspections
Survey Level and rod
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I and II defect/Observations or every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: TIMBER ABUTMENTS
CONTROL NUMBER: GS-III 16.01.03-3

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.02 PILES

DESCRIPTION

Piles are substructure elements of a bridge that transmit the loads from the superstructure and/or footing to the underlying soil or rock. Piles are generally completely buried, and, therefore, cannot be visually inspected. However piles which are exposed are used as intermediate supports for a bridge when multiple spans are required and are referred to as pile bents. Pile bents are transverse structural frames composed of piles and pile cap. Piles are constructed of reinforced concrete with (convention reinforcement), timber and steel.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the Standard Tool Section, may be required to perform the inspection of this subsystem.

1. Boat
2. Related safety equipment
3. Diving gear and all related safety equipment

SPECIAL SAFETY REQUIREMENTS

Level I and Level II inspections are performed by walking the perimeter of the bridge pile bents and observing defects from ground level thus passing traffic is a hazard. The inspection must be performed with prior approval of the Facility Manager, who will notify the necessary authorities so as to provide traffic safety measures and access. It is suggested that the inspector wear an orange safety vest.

Depending on the bridge type, a boat may be required to observe certain components. The inspectors are required to take all necessary safety measures and refer to the Master Safety Plan for guidance and compliance. The underwater inspection must be accomplished by a certified diver, as indicated in the introduction of this book, and in the Level III key description.

COMPONENT LIST

- 16.02.01 CONCRETE PILE
- 16.02.02 TIMBER PILE
- 16.02.03 STEEL PILE

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

13.02	RETAINING WALLS
19.01	ROADWAYS
20.01	RAILROAD
21.00	WATERFRONT (all subsystems)

16.02 PILES

STANDARD INSPECTION PROCEDURE

The Level I inspection shall be carried out for each component listed. The inspector will identify any physical defects existing in each component; will note the level of severity of each defect type; and measure the quantity of each defect.

COMPONENTS

♦ 16.02.01 CONCRETE PILE

A concrete pile is a vertical or inclined structural members that are driven, jetted, jacked or cast in placed into the ground. Their purpose is to transmit vertical and lateral loads from the superstructure into or through the soil stratum. Both above and underwater inspection portion of the piles shall be inspected. Underwater inspection by diver(s) will be a Level III inspection.

Potential defects which may be observed include collision damage and deterioration of the concrete surfaces.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Concrete Disintegration - Inspect Waterline, Splash Zone and Ground Line Areas:**			
Observation:			
a. Hollow spaces or voids present within concrete aggregate exposed concrete sound.	SF		
***{Severity L}			
b. Hollow spaces or voids present within concrete aggregate exposed or missing.	SF		
***{Severity M}			
c. Hollow spaces or voids present within concrete with exposed reinforcing bars.	SF		1
***{Severity H}			
Defect:			
*** Vertical Cracks - Piles, Pile Cap:**			
Observation:			
a. Hairline cracks less than 1/16" wide.	LF		
***{Severity L}			
b. Medium crack greater than 1/16" less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	1	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposit and spalling of cracks, reinforcing bars exposed.	LF		1
***{Severity H}			

16.02 PILES

COMPONENTS (Continued)

◆ **16.02.01 CONCRETE PILE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Horizontal Cracks - Piles, Pile Cap:**			
Observation:			
a. Hairline cracks less than 1/16" wide	LF		
***{Severity L}			
b. Medium crack greater than 1/16" less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	1	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposit and spalling of cracks, reinforcing bars exposed.	LF		1
***{Severity H}			
Defect:			
*** Bearing Seat - Pile Cap:**			
Observation:			
a. Light spalling and chipping of concrete.	SF		
***{Severity L}			
b. Dirt and debris accumulated on bearing seat.	SF		
***{Severity L}			
c. Spalling, cracking of concrete at edge of seat.	SF		
***{Severity M}			
d. Severe spalling and cracking with crushing of concrete and exposed reinforcing bars.	SF		1
***{Severity H}			

16.02 PILES

COMPONENTS (Continued)

◆ **16.02.01 CONCRETE PILES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Spalling:**			
Observation:			
a. Depression less than 1" deep and less than 6" in diameter.	SF		
***{Severity L}			
b. Depression greater than 1" deep and greater than 6" in diameter.	SF	1	
***{Severity M}			
c. Depression greater than 1" deep and greater than 6" in diameter with corroded re-bars.	SF		1
***{Severity H}			

Defect:

*** Scaling:**			
Observation:			
a. Loss of surface mortar greater than 1/4" deep and less than 1/2" deep with exposed aggregate.	SF		
***{Severity L}			
b. Loss of surface mortar greater than 1/2" deep less than 1" deep. Coarse aggregates are clearly exposed.	SF		
***{Severity M}			
c. Loss of coarse aggregate particles, as well as mortar surrounding coarse aggregates; depth of the loss greater than 1" deep, reinforcing bars exposed.	SF		1
***{Severity H}			

16.02 PILES

COMPONENTS (Continued)

◆ **16.02.01 CONCRETE PILE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Popout:**			
Observation:			
a. Conical shape holes less than 1/2" diameter.	SF		
***{Severity L}			
b. Conical shape Hole greater than 1/2" less than 2-1/2" diameter.	SF		
***{Severity M}			
c. Conical shape hole greater than 2-1/2" in diameter.	SF		
***{Severity M}			
Defect:			
*** Collision Damage:**			
Observation:			
a. Member out-of-alignment.	LF		1
***{Severity H}			
b. Member cracked, crushed or missing.	LF		1
***{Severity H}			

16.02 PILES

COMPONENTS (Continued)

◆ 16.02.02 TIMBER PILE

A timber pile is a vertical or inclined structural member that is driven, jacked or jetted into the ground. Their purpose is to transmit vertical and lateral loads from the superstructure into or through the soil stratum. Both above and underwater inspection portion of the piles shall be inspected. Underwater inspection by diver(s) will be a Level III inspection.

Potential defects which may be observed include collision damage and deterioration of the timber surfaces.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Deep Abrasions or Excessive Wear:**			
Inspect waterline, splash zone and ground line areas.			
Observation:			
a. Diameter loss less than 10%.	EA		
***{Severity L}			
b. Diameter loss less than 25%.	EA		
***{Severity M}			
c. Diameter loss greater than 25%.	EA		2
***{Severity H}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Splits - Piles, Pile Cap:**			
Observation:			
a. Partial split in member.	LF		
***{Severity L}			
b. Split completely through member.	LF		
***{Severity M}			
c. Member split and failed.	LF		2
***{Severity H}			

16.02 PILES

COMPONENTS (Continued)

◆ **16.02.02 TIMBER PILE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Decay:** Decay from rot/fungus is most likely to occur at connections, splices, support points or around bolt holes. This may be due either to the tendency of such areas to collect and retain moisture, or to bolt holes or cuts being made in the surface after the preservative treatment has been applied.			
Observation:			
a. Moist and stained or discolored area, signs of fungi, surface is solid.	SF		
***{Severity L}			
b. Surface spongy, member may shown signs of crushing.	SF	2	
***{Severity M}			
c. Brown and white - discolored area, member may show section loss and crushing.	SF		2
***{Severity H}			

Defect:

*** Parasites:**

Observation:			
a. Pinholes with dark stain area around the holes.	SF		
***{Severity L}			
b. Holes less than 1/8" dia., surface sag, and sawdust observed.	SF	2	
***{Severity M}			
c. Holes greater than 1/8" dia., surface channels, and crushing of the member.	SF		2
***{Severity H}			

16.02 PILES

COMPONENTS (Continued)

◆ **16.02.02 TIMBER PILE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Bearing Seat - Pile Cap:**			
Observation:			
a. Moist and stained, surface solid.	SF		
***{Severity L}			
b. Dirt and debris accumulated on bearing seat.	SF		
***{Severity L}			
c. Moist and stained, surface soft, slight crushing.	SF	2	
***{Severity M}			
d. Area soft and crumbly and seriously deteriorated.	SF		2
***{Severity H}			
Defect:			
*** Connections:**			
Observation:			
a. Loose fasteners.	EA		
***{Severity L}			
b. Member broken, spilt or damage.	LF		
***{Severity H}			
c. Missing fastener or anchors.	LF		
***{Severity H}			
Defect:			
*** Collision Damage:**			
Observation:			
a. Member out-of-alignment.	LF	2	1
***{Severity H}			
b. Member cracked, crushed or missing.	LF	2	1
***{Severity H}			

16.02 PILES

COMPONENTS (Continued)

◆ 16.02.03 STEEL PILE

A steel pile is a vertical or inclined structural member that is driven, jacked or cast in placed into the ground. Their purpose is to transmit vertical and lateral loads from the superstructure into or through the soil stratum. Both above and underwater inspection portions of the piles shall be inspected. Underwater inspection by diver(s) will be a Level III inspection.

Potential defects which may be observed include corrosion, collision damage and deterioration of the steel surfaces.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion - Piles and Pile Cap:**			
Observation:			
a. Surface rust no pitting evident.	LF		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	LF		
***{Severity M}			
c. Corrosion evident with loss to base section.	LF		3
***{Severity H}			
Defect:			
* **Straightness or Buckling - Pile:**			
Observation:			
a. Sign of wrinkles in pile web or flanges.	LF		
***{Severity M}			
b. Pile buckling.	LF		3
***{Severity H}			
Defect:			
* **Fungi Damaged or Marine Growth:**			
Observation:			
a. Section loss less than 10%.	EA		
***{Severity L}			
b. Section loss greater than 10%, less than 15%.	EA	3	
***{Severity M}			
c. Section loss greater than 15%.	EA		3
***{Severity H}			

16.02 PILES

COMPONENTS (Continued)

◆ **16.02.03 STEEL PILE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Cracks - Pile Cap, Piles and Bracing:**			
Observation:			
a. Hairline or greater crack, fillet of flanges.	LF		3
***{Severity H}			
b. Hairline or greater crack, fillet of web.	LF		3
***{Severity H}			
Defect:			
*** Connectors or Fasteners:**			
Observation:			
a. Loose bolts or fasteners.	EA		
***{Severity L}			
b. Missing fasteners or connectors.	EA		3
***{Severity H}			
c. Crack in weld.	LF		3
***{Severity H}			
d. Crack in connection plate.	LF		3
***{Severity H}			
Defect:			
*** Collision Damage:**			
Observation:			
a. Pile out of alignment.	LF		3
***{Severity H}			
b. Pile missing.	LF		3
***{Severity H}			

16.02 PILES

REFERENCES

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition.

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.02 PILES

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 16.02.01-1
2	GS-II 16.02.02-2
3	GS-II 16.02.03-3

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 16.02.01-1
2	GS-III 16.02.02-2
3	GS-III 16.02.03-3

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: TIMBER PILES
CONTROL NUMBER: GS-II 16.02.01-1

Application

This applies to the investigation of possible interior and exterior deterioration of timber piles due to decay (rot), or parasites.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the Level II.

Inspection Actions

1. Clean affected area.
2. Measure affected area.
3. Tap with hammer to determine extend of hollow or sound material.
4. Probe with ice pick.

Recommended inspection Frequency

When triggered by level I inspection and where Level II is utilized as the standard inspection procedure.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

SYSTEM/COMPONENT: CONCRETE PILES
CONTROL NUMBER: GS-II 16.02.02-2

Application

This applies to the investigation of concrete piles deterioration due to spalling from delamination.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the level II.

Inspection Actions

1. Clean loose concrete from area to be inspected.
2. Measure the affected area.
3. Tap the affected area with a hammer to determine extent of unsound or hollow concrete.

Recommended Inspection Frequency

When triggered by level I inspection and where Level II is utilized as the standard inspection procedure.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete
5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: STEEL PILES
CONTROL NUMBER: GS-II 16.02.03-3

Application

This applies to the investigation of heavy fungi growth on steel piles.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the Level II.

Inspection Actions

1. Clean growth from area to be inspected.

2. Measure affected area, utilize calipers and ruler to determine an approximate pile section loss.

Recommended inspection Frequency

When triggered by Level I inspection and where Level II is utilized as the standard inspection procedure.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public Roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: TIMBER PILES
CONTROL NUMBER: GS-III 16.02.01-1

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a timber pile.

Whereas the purpose of the Level I inspection was to record the observable defects at the piles, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the piles and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the piles.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER PILES
CONTROL NUMBER: GS-III 16.02.01-1

Inspection Actions

1. Prior to making a field inspection of the observed defect, review all past records concerning the piles and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, reservoir level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance,or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the piles.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for piles include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER PILES
CONTROL NUMBER: GS-III 16.02.01-1

Advanced Test or Inspection Method	Applicable Observed Defects
1. Increment borer	interior and exterior deterioration of timber due to decay or parasites
2. Ultrasonic	interior deterioration
3. Moisture content	deterioration due to decay or parasites
4. Soil borings	soil instability, movement and settlement
5. laboratory tests on soil samples (strength tests, moisture content, consolidation tests, etc.)	soil instability
6. Underwater inspection	erosion, scouring and undermining
7. Survey measurement	pile movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Surveying equipment
Increment borer
Moisture meter
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by a Level I and Level II defect/observation or every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER PILES
CONTROL NUMBER: GS-III 16.02.01-1

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: CONCRETE PILES
CONTROL NUMBER: GS-III 16.02.02-2

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a concrete pile.

Whereas the purpose of the Level I inspection was to record the observable defects at the piles, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the piles and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the piles.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PILES
CONTROL NUMBER: GS-III 16.02.02-2

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the piles and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the piles.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for piles include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PILES
CONTROL NUMBER: GS-III 16.02.02-2

Advanced Test or Inspection Method	Applicable Observed Defects
1. Infrared Thermography and ground probing radar	cracks and voids
2. Concrete coring	concrete deterioration
3. Laboratory tests on concrete (core, strength tests, abrasion, absorption,sulfate soundness, unit weight	concrete deterioration
4. Ultrasonic test	cracks and voids in concrete
5. Half-cell test	corrosion to reinforcement steel
6. Soil borings	soil instability, movement and settlement
7. Laboratory tests on soil samples (strength tests, moisture content, consolidation tests, etc.)	soil instability
8. Underwater inspection	erosion, scouring and undermining
9. Survey measurements	pile movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Surveying equipment
Navigable boat with related safety equipment.
Industry required testing equipment needed to perform the advanced investigation method chosen.

Recommended Inspection Frequency

Triggered by Level I and Level II defect/observations or every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PILES
CONTROL NUMBER: GS-III 16.02.02-2

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: STEEL PILES
CONTROL NUMBER: GS-III 16.02.03-3

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a steel pile.

Whereas the purpose of the Level I inspection was to record the observable defects at the piles, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the piles and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the piles.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: STEEL PILES
CONTROL NUMBER: GS-III 16.02.03-3

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the piles and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the piles.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for steel piles include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: STEEL PILES
CONTROL NUMBER: GS-III 16.02.03-3

Advanced Test or Inspection Method		Applicable Observed Defects
1.	Grinding and or sandblasting, using caliper to measure section loss	corrosion of steel and section loss
2.	Magnetic particle	cracks in steel or welds
3.	Dye-Penetrant	cracks in steel or welds
4.	Ultrasonic test	cracks and voids in steel
5.	Soil boring	Soil instability, movement and settlement
6.	Laboratory test on soil sample (Strength tests, moisture content, consolidation test, etc)	Soil instability
7.	Underwater Inspection	erosion, scouring and undermining
8.	Survey measurements	pile movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Grinder or sandblasting equipment
Surveying equipment
Navigable boat and related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

Triggered by Level I and Level II defect/observations or every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: STEEL PILES
CONTROL NUMBER: GS-III 16.02.03-3

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.03 PIERS

DESCRIPTION

A pier is an intermediate substructure unit located between the ends of a bridge. Its function is to support the superstructure at intermediate intervals with minimal obstruction to the flow of traffic or water. The most common pier types are: solid shaft, columns, columns with web wall, and cantilever. The primary material used in these constructions are plain cement concrete, reinforced concrete, stone masonry, timber, steel or a combination of these materials.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the Standard Tool Section, may be required to perform the inspection of this subsystem.

1. Boat
2. Related safety equipment
3. Diving gear and related safety equipment

SPECIAL SAFETY REQUIREMENTS

Level I and Level II inspections are performed by walking the perimeter of the bridge pier and observing defects from ground level, utilizing binoculars where required thus passing traffic is a hazard. The inspection must be performed with prior approval of the Facility Manager, who will notify the necessary authorities so as to provide traffic safety measures and access. It is suggested that the inspector wear an orange safety vest.

Depending on the bridge type a boat may be required to observe certain components, and the inspectors are required to take all necessary safety measures and refer to the Master Safety Plan for guidance and compliance. The underwater inspection must be accomplished by a certified diver, as indicated in the introduction of this book, and in the Level III key description.

COMPONENT LIST

- 16.03.01 TIMBER PIER
- 16.03.02 CONCRETE PIER
- 16.03.03 MASONRY PIER
- 16.03.04 STEEL PIER

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

13.02	RETAINING WALLS
19.01	ROADWAYS
20.01	RAILROAD
21.00	WATERFRONT (all subsystems)

16.03 PIERS

STANDARD INSPECTION PROCEDURE

The Level I inspection shall be carried out for each component listed. The inspector will identify any physical defects existing in each component; will note the level of severity of each defect type; and measure the quantity of each defect.

COMPONENTS

◆ 16.03.01 TIMBER PIER

A timber pier consist of a footing, vertical elements (two or more rows of columns or posts), pier cap, and longitudinal and transverse bracing. The footing transmit the pier loads to the soil, rock or to some other foundation unit such as piles, caissons or drilled shaft. Since the foundation (footing and piles) are buried, this component cannot be inspected. The pile cap receives and distributes the superstructure loads to columns which are transmitted to the footing. Both above and underwater inspection portions of the piers shall be inspected. Underwater inspection by diver(s) shall be a Level III inspection.

The potential defects which may be observed include erosion or scouring, vertical, lateral and rotational movement due to soil instability and deterioration to timber members.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Bearing Seat - Pier Cap:**			
Observation:			
a. Moist and stained, surface solid.	SF		
***{Severity L}			
b. Dirt and debris accumulated on bearing seat.	SF		
***{Severity L}			
c. Moist and stained, surface soft, slight crushing	SF	1	
***{Severity M}			
d. Area soft and crumbly and seriously deteriorated.	SF		1
***{Severity H}			
Defect:			
*** Splits - Cap, Columns and Bracing:**			
Observation:			
a. Partial split in member.	LF		
***{Severity L}			
b. Split completely through member.	LF		
***{Severity M}			
c. Member split and failed.	LF		1
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.01 TIMBER PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Decay - Pier Cap, Columns and Joints:** Decay from rot/fungus is most likely to occur at connections, splices, support points or around bolt holes. This may be due either to the tendency of such areas to collect and retain moisture, or to bolts, holes or cuts being made in the surface after the preservative treatment has been applied.			
Observation:			
a. Moist and stain or discolored area, signs of fungi, surface is solid.	SF		
***{Severity L}			
b. Surface spongy, member may shown signs of crushing	SF	1	
***{Severity M}			
c. Brown and white - discolored area, member may show section loss and crushing.	SF		1
***{Severity H}			

Defect:

*** Weathering - Cap, Columns and Bracing:**			
Observation:			
a. Surface of wood is rough and corrugated and member may be warped.	SF		
***{Severity L}			
b. Surface of wood is rough and corrugated with cracks partially through the wood member, may have minor section loss. Member may be warped.	SF	1	
***{Severity M}			
c. Large cracks extend deeply or completely through the wood.	SF		1
***{Severity H}			
d. Wood is crumbly and seriously deteriorated.	SF		1
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.01 TIMBER PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Parasites - Pier Cap, Columns and Bracing:** (termites, carpenter ants, powder post beetles)			
Observation:			
a. Pinholes with dark stained area around the holes.	SF		
***{Severity L}			
b. Holes less than 1/8" dia., surface sag, and sawdust observed.	SF	1	
***{Severity M}			
c. Holes greater than 1/8" dia., surface channels, and crushing of the member.	SF		1
***{Severity H}			
Defect:			
*** Connections:**			
Observation:			
a. Loose fasteners.	EA		
***{Severity L}			
b. Member broken, spilt or damage.	LF		
***{Severity H}			
c. Missing fastener or anchors.	LF		
***{Severity H}			
Defect:			
*** Collision Damage:**			
Observation:			
a. Member out-of-alignment.	LF		1
***{Severity H}			
b. Member cracked, crushed or missing.	LF		1
***{Severity H}			
Defect:			
*** Scouring or Erosion - Base of Footing:**			
Observation:			
a. Voids less than 2".	SF		
***{Severity L}			
b. Voids greater than 2", less than 6".	SF		
***{Severity H}			
c. Undermining of footing, with voids greater than 6".	SF		1
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.01 TIMBER PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Deflection Pier Cap:**			
Observation:			
a. Slight deflection of member when vehicle passes.	LF		
***{Severity L}			
b. Noticeable deflection of member when vehicle passes.	LF		
***{Severity M}			
c. Large deflection of member when vehicle passes.	LF		1
***{Severity H}			
d. Permanent deformation in member.	LF		1
***{Severity H}			
Defect:			
*** Rotational Movement:**			
Observation:			
a. Pier rotated or tipping	EA		1
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ 16.03.02 CONCRETE PIER

A concrete pier consist of a footing, vertical elements (columns, solid shaft or columns with web wall) and pier cap. The footing transmit the pier loads to the soil, rock or to some other foundation unit such as piles, caissons or drilled shaft. Since the foundation (footing and piles) are buried, this component cannot be inspected. The pile cap receives and distributes the superstructure loads to the columns or shaft which are transmitted to the footing. Both above and underwater inspection portions of the piers shall be inspected. Underwater inspection by diver(s) shall be a Level III inspection.

Potential defects which may be observed include erosion or scour, vertical, lateral and rotational movement of the pier due to instability of the soil and deterioration of the concrete surfaces.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Concrete Disintegration - Inspect Waterline, Splash Zone and Ground Line Areas:**			
Observation:			
a. Hollow spaces or voids present within concrete aggregate exposed concrete sound.	SF		
***{Severity L}			
b. Hollow spaces or voids present within concrete aggregate exposed or missing.	SF		
***{Severity M}			
c. Hollow spaces or voids present within concrete with exposed reinforcing bars.	SF		2
***{Severity H}			
Defect:			
*** Erosion or Scouring - Base of Pier:**			
Observation:			
a. Voids less than 2".	SF		
***{Severity L}			
b. Voids greater than 2", less than 6".	SF		
***{Severity H}			
c. Undermining of base voids greater than 6".	SF		2
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.02 CONCRETE PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Horizontal Cracks - Pier Cap, Wall or Columns:**			
Observation:			
a. Hairline cracks less than 1/16" wide	LF		
***{Severity L}			
b. Medium crack greater than 1/16", less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposit, spalling of cracks, and reinforcing bars exposed.	LF		2
***{Severity H}			
Defect:			
*** Honeycombing:**			
Observation:			
a. Hollow spaces or voids present within concrete, aggregate partially exposed, concrete is sound around damaged area.	SF		
***{Severity L}			
b. Hollow spaces or voids present with concrete with exposed aggregate, concrete is sound around defected area.	SF	2	
***{Severity M}			
c. Hollow spaces or voids present within concrete with exposed reinforcing bars.	SF		2
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

16.03.02 CONCRETE PIER (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Diagonal Cracks - Pier Cap, Wall or Columns:**			
Observation:			
a. Hairline cracks less than 1/16" wide.	LF		
***{Severity L}			
b. Medium crack greater than 1/16", less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposit, spalling of cracks and reinforcing bars exposed.	LF		2
***{Severity H}			

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Vertical Cracks - Pier Cap, Wall, or Columns:**			
Observation:			
a. Hairline cracks less than 1/16" wide.	LF		
***{Severity L}			
b. Medium crack greater than 1/16", less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposit, spalling of cracks and reinforcing bars exposed.	LF		2
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.02 CONCRETE PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Spalling - Pier Cap, Wall or Columns:**			
Observation:			
a. Depression less than 1" deep and less than 6" in diameter.	SF		
***{Severity L}			
b. Depression greater than 1" deep and greater than 6" in diameter.	SF	2	
***{Severity M}			
c. Depression greater than 1" deep and greater than 6" in diameter with corroded re-bars.	SF		2
***{Severity H}			
Defect:			
*** Scaling - Pier Cap, Wall or Columns:**			
Observation:			
a. Loss of surface mortar greater than 1/4" deep and less than 1/2" deep with exposed aggregate.	SF		
***{Severity L}			
b. Loss of surface mortar greater than 1/2" deep and less than 1" deep. Coarse aggregates are clearly exposed.	SF		
***{Severity M}			
c. Loss of coarse aggregate particles, as well as mortar surrounding coarse aggregates; depth of the loss greater than 1" deep, reinforcing bars exposed.	SF		2
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.02 CONCRETE PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Rotational Movement:**			
Observation:			
a. Pier rotated or tipping.	LF		2
***{Severity H}			
Defect:			
*** Bearing Seat or Pedestal:**			
Observation:			
a. Light spalling and chipping of concrete.	SF		
***{Severity L}			
b. Dirt and debris accumulated on bearing seat.	SF		
***{Severity L}			
c. Spalling, cracking of concrete at edge of seat.	SF		
***{Severity M}			
d. Severe spalling and cracking with crushing of concrete and exposed reinforcing bars.	SF		2
***{Severity H}			
Defect:			
*** Collision Damage:**			
Observation:			
a. Member out-of-alignment.	LF		2
***{Severity H}			
b. Member cracked, crushed or missing.	LF		2
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.02 CONCRETE PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Construction Joints:**			
Observation:			
a. Joint separation or movement less than 1/16".	LF		
***{Severity L}			
b. Joint separation or movement greater than 1/16", less than 1/4".	LF		
***{Severity M}			
c. Joint separation or movement greater than 1/4".	LF		2
***{Severity H}			
Defect:			
*** Popout:**			
Observation:			
a. Conical shape holes less than 1/2" diameter.	SF		
***{Severity L}			
b. Conical shape hole greater than 1/2" less than 2-1/2" diameter.	SF		
***{Severity M}			
c. Conical shape hole greater than 2-1/2" in diameter.	SF		
***{Severity M}			

16.03 PIERS

COMPONENTS (Continued)

◆ 16.03.03 MASONRY PIER

A masonry pier consist of a footing and pier shaft. The footing transmit the pier loads to the soil, rock or to some other foundation unit such as piles, caissons or drill shaft. Since the foundation (footing and piles) are buried, this component cannot be inspected. The pier shaft receives and distributes the superstructure loads which are transmitted to the footing. Both above and underwater inspection portion of the piers shall be inspected. Underwater inspection by diver(s) shall be a Level III inspection.

Potential defects which may be observed include erosion or scour, vertical, lateral and rotational movement of the pier due to instability of the soil and deterioration of the concrete surfaces.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Erosion or Scouring - Base of Pier:**			
Observation:			
a. Voids less than 2".	SF		
***{Severity L}			
b. Voids greater than 2", less than 6".	SF		
***{Severity H}			
c. Undermining of base voids greater than 6".	SF		3
***{Severity H}			
Defect:			
*** Bearing Seat:**			
Observation:			
a. Light spalling and chipping of masonry.	SF		
***{Severity L}			
b. Dirt and debris accumulated on bearing seat.	SF		
***{Severity L}			
c. Spalling, cracking of masonry at edge of seat.	SF		
***{Severity M}			
d. Severe spalling and cracking with crushing of masonry.	SF		3
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.03 MASONRY PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Mortar Joint:**			
Observation:			
a. Mortar joint cracked with no voids, masonry stone sound.	SF		
***{Severity L}			
b. Mortar joint deteriorated with voids, vegetation growing from joint, masonry stone loose.	SF		
***{Severity M}			
c. Mortar joint totally deteriorated, masonry stone missing.	SF		3
***{Severity H}			
Defect:			
*** Masonry Stone Deterioration:**			
Observation:			
a. Masonry stone, minor spalling and hairline cracks.	SF		
***{Severity L}			
b. Masonry stone, spalling with cracks and chipping, stone loose.	SF		
***{Severity M}			
c. Masonry stone, spalling with large cracks and chipping, section loss greater than 15%.	SF		3
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.03 MASONRY PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Rotational Movement:**			
Observation:			
a. Pier rotated or tipping.	LF		3
***{Severity H}			
Defect:			
*** Collision Damage:**			
Observation:			
a. Member out-of-alignment.	LF		3
***{Severity H}			
b. Member cracked, crushed or missing.	LF		3
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ 16.03.04 STEEL PIER

A steel pier consist of a footing, vertical elements (two or more rows of columns), pier cap, and longitudinal and transverse bracing. The footing transmit the pier loads to the soil, rock or to some other foundation unit such as piles, caissons or drilled shaft. Since the foundation (footing and piles) are buried, this component cannot be inspected. The pile cap receives and distributes the superstructure loads to columns which are transmitted to the footing. Both above and underwater inspection portions of the piers shall be inspected. Underwater inspection by diver(s) shall be a Level III inspection.

Potential defects which may be observed includes corrosion, cracks due to out-of-plane distortion, collision damage and overload damage.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion - Pier Cap, Columns and Bracings:**			
Observation:			
a. Surface rust no pitting evident.	LF		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	LF		
***{Severity M}			
c. Corrosion evident with loss to base section metal.	LF		4
***{Severity H}			
Defect:			
*** Cracks - Pier Cap, Columns and Bracing:**			
Observation:			
a. Hairline or greater crack, fillet of flanges.	LF		4
***{Severity H}			
b. Hairline or greater crack, fillet of web.	LF		4
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.04 STEEL PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Cracks - Attachment Welds:** Check all vertical and longitudinal stiffener welds for cracks. Observation:			
a. Hairline or greater crack, at toe of weld or adjacent metal.	LF		4
***{Severity H}			
Defect:			
*** Straightness or Buckling of Member:** Observation:			
a. Sign of wrinkles in web and or stiffener plate at support.	LF		
***{Severity M}			
b. Sign of wrinkles in flanges.	LF		
***{Severity M}			
c. Sign of buckling in web and or stiffener plate at support.	LF		4
***{Severity H}			
d. Sign of buckling in flanges.	LF		4
***{Severity H}			
Defect:			
*** Deflection Pier Cap:** Observation:			
a. Slight deflection of member when vehicle passes.	LF		
***{Severity L}			
b. Noticeable deflection of member when vehicle passes.	LF		
***{Severity M}			
c. Large deflection of member when vehicle passes.	LF		4
***{Severity H}			
d. Permanent deformation of member.	LF		4
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.04 STEEL PIER (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion - Gussets or Connection Plates:**			
Observation:			
a. Surface rust no pitting evident.	SF		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	SF		
***{Severity M}			
c. Corrosion evident with loss to base section.	SF		4
***{Severity H}			
Defects:			
*** Corrosion - Bolts or Fasteners:**			
Observation:			
a. Surface rust no pitting evident.	EA		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	EA		
***{Severity M}			
c. Corrosion evident with loss to base section.	EA		4
***{Severity H}			
Defect:			
*** Connectors or Fasteners:**			
Observation:			
a. Loose bolts or fasteners.	EA		
***{Severity L}			
b. Missing fasteners or connectors.	EA		
***{Severity H}			
c. Crack in weld.	LF		4
***{severity H}			
d. Crack in connection plate.	LF		4
***{Severity H}			

16.03 PIERS

COMPONENTS (Continued)

◆ **16.03.04 STEEL PIER (CONTINUE)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Rotational Movement:**			
Observation:			
a. Pier rotated or tipping.	LF		4
***{Severity H}			
Defect:			
*** Vehicular Damage:**			
Observation:			
a. Pier column out of alignment.	LF		4
***{Severity H}			
b. Bracing member out of alignment.	LF		4
***{Severity H}			

16.03 PIERS

REFERENCES

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition.

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.03 PIERS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 16.03.01-1
2	GS-II 16.03.02-2

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 16.03.01-1
2	GS-III 16.03.02-2
3	GS-III 16.03.03-3
4	GS-III 16.03.04-4

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: TIMBER PIER
CONTROL NUMBER: GS-II 16.03.01-1

Application

This applies to the investigation of possible interior and exterior deterioration of timber piers due to decay (rot), or parasites.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No Special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the Level II.

Inspection Actions

1. Clean affected area.
2. Measure affected area.
3. Tap with hammer to determine extend of hollow or sound material.
4. Probe with ice pick.

Recommended Inspection Frequency

As triggered by Level I or Level II defect/observation.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: CONCRETE PIERS
CONTROL NUMBER: GS-II 16.03.02-2

Application

This applies to the investigation of concrete bridge piers deterioration due to spalling from delamination.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the level II.

Inspection Actions

1. Clean loose concrete from area to be inspected.
2. Measure the affected area.
3. Tap the affected area with a hammer to determine extent of unsound or hollow concrete.

Recommended Inspection Frequency

As Triggered by a Level I or Level II defect/observation.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of concrete
5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: TIMBER PIERS
CONTROL NUMBER: GS-III 16.03.01-1

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a timber pier.

Whereas the purpose of the Level I inspection was to record the observable defects at the piers, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the piers and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridge.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the piers.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER PIERS
CONTROL NUMBER: GS-III 16.03.01-1

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the piers and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, reservoir level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance,or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the piers.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for piers include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER PIERS
CONTROL NUMBER: GS-III 16.03.01-1

Advanced Test or Inspection Method	Applicable Observed Defects
1. Increment borer	interior and exterior deterioration of timber due to decay or parasites
2. Ultrasonic test	interior deterioration
3. Moisture content	deterioration due to decay or parasites
4. Soil borings	soil instability, movement and settlement
5. Laboratory tests on soil samples (strength tests, moisture content, consolidation tests, etc.)	soil instability
6. Underwater inspection	erosion, scouring and undermining
7. Survey measurement	pier movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Surveying equipment
Navigable boat and related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I or Level II defect/observation or every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER PIERS
CONTROL NUMBER: GS-III 16.03.01-1

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: CONCRETE PIERS
CONTROL NUMBER: GS-III 16.03.02-2

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a concrete pier.

Whereas the purpose of the Level I inspection was to record the observable defects at the piers, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the piers and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the piers.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PIERS
CONTROL NUMBER: GS-III 16.03.02-2

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the piers and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance,or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the piers.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for piers include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PIERS
CONTROL NUMBER: GS-III 16.03.02-2

Advanced Test or Inspection Method	Applicable Observed Defects
1. Infrared thermography and ground probing radar	concrete cracking
2. Concrete coring	concrete deterioration
3. Laboratory tests on concrete (core, strength tests, abrasion, absorption,sulfate soundness, unit weight	concrete deterioration
4. Ultrasonic test	cracks and voids in concrete
5. Half-cell test	corrosion to reinforcement steel
6. Soil borings	soil instability, movement and settlement
7. Laboratory tests on soil samples (strength tests, moisture content, consolidation tests, etc.)	soil instability
8. Underwater inspection	erosion, scouring and undermining
9. Survey measurements	pier movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Surveying equipment
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level II or Level II defect/observation or every 3 years

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PIERS
CONTROL NUMBER: GS-III 16.03.02-2

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: MASONRY PIERS
CONTROL NUMBER: GS-III 16.03.03-3

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a masonry pier.

Whereas the purpose of the Level I inspection was to record the observable defects at the piers, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the piers and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions at the piers.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Equipment

Special safety equipment needed for the Level III inspection of masonry piers are listed in the standards developed for the Standard Inspection of piers.

Special Safety Requirements

Special safety requirements are as set forth in the standards developed for the Standard Inspection of masonry piers.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: MASONRY PIERS
CONTROL NUMBER: GS-III 16.03.03-3

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the piers and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance,or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the piers.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for piers include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: MASONRY PIERS
CONTROL NUMBER: GS-III 16.03.03-3

Advanced Test or Inspection Method		Applicable Observed Defects
1.	Infrared Thermography and ground probing radar	voids in masonry abutments
2.	Ultrasonic test	cracks and voids in masonry
3.	Soil borings	soil instability, movement and settlement
4.	Laboratory tests on soil samples (strength tests, moisture content, consolidation tests, etc.)	soil instability
5.	Underwater inspection	erosion, scouring and undermining
6.	Survey measurement	pier movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Survey Level and rod
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I or Level II defect/observation or every 3 years

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: MASONRY PIERS
CONTROL NUMBER: GS-III 16.03.03-3

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4

COMPONENT: STEEL PIERS
CONTROL NUMBER: GS-III 16.03.04-4

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at a steel pier.

Whereas the purpose of the Level I inspection was to record the observable defects at the piers, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the piers and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridge piers.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: STEEL PIERS
CONTROL NUMBER: GS-III 16.03.04-4

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the piers and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the piers.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for several Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for bridge piers include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: STEEL PIERS
CONTROL NUMBER: GS-III 16.03.04-4

	Advanced Test or Inspection Method	Applicable Observed Defects
1.	Grinding or sandblasting, using caliper to measure section loss	corrosion of steel and section loss
2.	Magnetic particle	cracks in steel or welds
3.	Dye-Penetrant	cracks in steel or welds
4.	Ultrasonic test	cracks and voids in steel
5.	Soil boring	soil instability, movement and settlement
6.	Laboratory test on soil sample (Strength tests, moisture content, consolidation test, etc)	soil instability
7.	Underwater Inspection	erosion, scouring undermining
8.	Survey measurement	pier movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Grinder or sandblasting equipment
Navigable boat with related safety equipment
Surveying equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I or Level II defect/observation or every 3 years

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: STEEL PIERS
CONTROL NUMBER: GS-III 16.03.04-4

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.04 SUPERSTRUCTURE

DESCRIPTION

The superstructure is designed to carry dead and live loads associated with the structural deck to the substructure (abutments or piers). The superstructure includes primary members; floor system with two or more main supporting members, secondary members, connections and bearings.

The floor system supports the deck or driving surface. It may consist of either closely spaced transverse floor beams or several longitudinal stringers carried by transverse floor beams. In floor systems of this type, stringers are usually wide flange beams, and the floor beams may be either plate girders, wide flange beams, or trusses. When floor beams only are used, they may be rolled or plate girders.

The main supporting members may be steel, timber or concrete beams; steel plate girders, steel or timber trusses; steel or concrete rigid frames. Beams and girders are considered single elements while trusses have several identifiable parts: the chords, which are generally longitudinal members at the top and bottom of a truss, and the verticals and diagonals which are called web members.

Secondary members for beams and girder structures are bracing which include diaphragms and cross frames. Trusses are braced with portal cross frames, and sway bracing. Diaphragms and cross frames stabilize the beams or trusses and distributes loads between them. A diaphragm is usually a solid web member, either a rolled shape or built-up member, while a cross frame is a truss panel, or frame.

The beams, girders, stringers, trusses and other members which form a complete bridge superstructure are designed to support certain loads. Each of these members must transmit its load through connections to supporting members. As a means to transmit this load fasteners such as bolts or welds are used with connection material, made of angles, plates or pieces of rolled sections.

Bearings transmit and distribute the superstructure loads to the substructure, and they permit the superstructure to undergo necessary movement without developing harmful overstresses.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the Standard Tool Section, are required to perform the inspection of this subsystem.

1. Boat
2. Related safety equipment

16.04 SUPERSTRUCTURE

SPECIAL SAFETY REQUIREMENTS

Level I and Level II inspections are performed by walking under the superstructure and observing from ground level, utilizing a binocular where required thus passing traffic is a hazard. The inspection must be performed with prior approval of the Facility Manager, who will notify the necessary authorities so as to provide traffic safety measures and access. It is suggested that the inspector wear an orange safety vest.

Depending on the bridge type a boat may be required to observe certain components. The inspectors are required to take all necessary safety measures and refer to the Master Safety Plan for guidance and compliance.

COMPONENT LIST

- 16.04.01 TIMBER PRIMARY AND SECONDARY MEMBERS
- 16.04.02 CONCRETE PRIMARY AND SECONDARY MEMBERS
- 16.04.03 STEEL PRIMARY AND SECONDARY MEMBERS
- 16.04.04 CONNECTIONS
- 16.04.05 BEARINGS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

19.01	ROADWAYS
20.01	RAILROAD
29.00	SITE ELECTRICAL (all subsystems)
13.02	RETAINING WALLS

STANDARD INSPECTION PROCEDURE

The Level I inspection shall be carried out for each component listed. The inspector will identify any physical defects existing in each component; will note the level of severity of each defect type; and measure the quantity of each defect.

16.04 SUPERSTRUCTURE

COMPONENTS

♦ 16.04.01 TIMBER PRIMARY AND SECONDARY MEMBERS

There are two basic classifications in timber bridge construction; solid sawn and glued-laminated. A solid sawn beam is simply a tree, with its bark and branches removed, and sawn down to the desired size. A glulam member is made by gluing strips of wood together to form a structural member of the desired size.

Potential defects which may be observed include; decay, parasites, vehicular damage, overload.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Beam End - At Supports:**			
Observation:			
a. Moist and stained, surface solid.	SF		
***{Severity L}			
b. Moist and stained, surface soft, beam slight crushing.	SF	1	
***{Severity M}			
c. Area soft and crumbly and seriously deteriorated.	SF		1
***{Severity H}			
Defect:			
*** Decay:** Decay from rot/fungus is most likely to occur at connections, splices, support points or around bolt holes. This may be due either to the tendency of such areas to collect and retain moisture, or to bolt holes or cuts being made in the surface after the preservative treatment has been applied.			
Observation:			
a. Moist and stain or discolored area, signs of fungi, surface is solid.	SF		
***{Severity L}			
b. Surface spongy, member may shown signs of crushing.	SF	1	
***{Severity M}			
c. Brown and white - discolored area, member may show section loss and crushing.	SF		1
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ 16.04.01 TIMBER PRIMARY AND SECONDARY MEMBERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Parasites:**			
(Termites, carpenter ants, powder post beetles)			
Observation:			
a. Pinholes with dark stain area around the holes.	SF		
***{Severity L}			
b. Holes less than 1/8" diameter, surface sag, and sawdust observed.	SF	1	
***{Severity M}			
c. Holes greater than 1/8" diameter, surface channels, and crushing of the member.	SF		1
***{Severity H}			
Defect:			
*** Horizontal Splits:**			
Observation:			
a. Partial splits in member.	LF		
***{Severity M}			
b. Split completely through member.	LF		
***{Severity H}			
c. Member split and completely failed.	LF		1
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ 16.04.01 TIMBER PRIMARY AND SECONDARY MEMBERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Vehicular Damage - Primary and Secondary Members:**			
Observation:			
a. Member out of alignment.	LF		1
***{Severity H}			
b. Member split or broken at cracks.	LF		1
***{Severity H}			
Defect:			
*** Deflection:**			
Observe deflection of members with passing traffic.			
Observation:			
a. Slight deflection in member.	LF		
***{Severity L}			
b. Noticeable deflection in member.	LF		
***{Severity M}			
c. Permanent sagging or deflection in member.	LF		1
***{Severity H}			
Defect:			
*** Straightness:**			
Observation:			
a. Slight bowing in member.	LF		
***{Severity L}			
b. Noticeable bowing in member.	LF		
***{Severity M}			
c. Excessive bowing in member.	LF		1
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ 16.04.02 CONCRETE PRIMARY AND SECONDARY MEMBERS

Concrete beams and primary members transfer dead and live loads to the substructure (abutments or piers). The most common concrete bridges are the slab, T-beam, I-beam and box girder types. Concrete superstructure are classified according to the method of construction, cast-in-placed or precast and the method of reinforcement, conventional (mild steel).

Potential defects which may be observed include; cracking, scaling, delamination, spalling, honeycombs, collision damage, overload damage and reinforcing steel corrosion.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Beam End - At supports:**			
Observation:			
a. Light spalling and chipping of concrete.	LF		
***{Severity L}			
b. Spalling and cracks of beam.	LF		2
***{Severity M}			
c. Spalling, cracks and crushing, at end of beam.	LF		2
***{Severity H}			
Defect:			
*** Horizontal Cracks:**			
Observation:			
a. Hairline cracks less than 1/16 wide, slight staining of concrete surface.	LF		
***{Severity L}			
b. Medium crack greater than 1/16" less, than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit, spalling of cracks and reinforcing bars exposed.	LF		2
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ **16.04.02 CONCRETE PRIMARY AND SECONDARY MEMBERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Diagonal Cracks - Near supports:**			
Observation:			
a. Hairline cracks less than 1/16 wide, slight staining of concrete surface.	LF		
***{Severity L}			
b. Medium cracks greater than 1/16" less than " 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit, spalling of cracks, and reinforcing bars exposed.	LF		2
***{Severity H}			
Defect:			
Vertical Cracks:			
Observation:			
a. Hairline cracks less than 1/16" wide, slight staining of concrete surface.	LF		
***{Severity L}			
b. Medium cracks greater than 1/16" less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit and spalling of cracks.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with signs of efflorescence deposit, spalling of cracks, and reinforcing bars exposed.	LF		2
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ 16.04.02 CONCRETE PRIMARY AND SECONDARY MEMBERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Scaling:**			
Observation:			
a. Loss of surface mortar greater than 1/4" deep and less than 1/2" deep with exposed aggregate.	SF		
***{Severity L}			
b. Loss of surface mortar greater than 1/2" deep and less than 1" deep. Coarse aggregates are clearly exposed.	SF		
***{Severity M}			
c. Loss of coarse aggregate particles, as well as mortar surrounding coarse aggregates; depth of the loss greater than 1" deep, reinforcing bars exposed.	SF		
***{Severity H}			
Defect:			
*** Honeycombing:**			
Observation:			
a. Hollow spaces or voids present within concrete, aggregated partially exposed, concrete is sound around damage area.	SF		
***{Severity L}			
b. Hollow spaces or voids present with concrete with exposed aggregate, concrete is sound around defected area.	SF	2	
***{Severity M}			
c. Hollow spaces or voids present within concrete with exposed rebars.	SF		2
Defect:			
*** Vehicular Damage - Primary and Secondary Members:**			
Observation:			
a. Member out of alignment.	LF		2
***{Severity H}			
b. Member cracked with section loss	LF		2
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ **16.04.02 CONCRETE PRIMARY AND SECONDARY MEMBERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Spalling:**			
Observation:			
a. Depression less than 1" deep and less than 6" in diameter.	SF		
***{Severity L}			
b. Depression greater than 1" deep and greater than 6" in diameter.	SF	2	
***{Severity M}			
c. Depression greater than 1" deep and greater than 6" in diameter with corroded reinforcing bars.	SF		2
***{Severity H}			
Defect:			
*** Deflection:**			
Observe deflection of members with passing traffic.			
Observation:			
a. Slight deflection in member.	LF		
***{Severity L}			
b. Noticeable deflection in member.	LF		
***{Severity M}			
c. Permanent sagging or deflection in member.	LF		2
***{Severity H}			
Defect:			
*** Popout:**			
Observation:			
a. Conical shape holes less than 1/2" diameter.	SF		
***{Severity L}			
b. Conical shape hole greater than 1/2" less than 2-1/2" diameter.	SF		
***{Severity M}			
c. Conical shape hole greater than 2-1/2" in diameter.	SF		
***{Severity M}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ 16.04.03 STEEL PRIMARY AND SECONDARY MEMBERS

Steel is one of the most common materials used in superstructures. There are many different types of superstructures, including: rolled multi-beam, fabricated multi-girder, two girder, box girder, trusses, rigid frames and many more.

Potential defects which may be observed includes corrosion, fatigue cracking due to out-of-plane distortion, collision damage and overload damage.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion - Top and Bottom Flange:**			
Observation:			
a. Surface rust no pitting evident.	LF		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	LF		
***{Severity M}			
c. Corrosion evident with loss to base section.	LF		3
***{Severity H}			
Defect:			
* **Corrosion - Web Plate:**			
Observation:			
a. Surface rust no pitting evident.	SF		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	SF		
***{Severity M}			
c. Corrosion evident with loss to base section.	SF		3
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ **16.04.03 STEEL PRIMARY AND SECONDARY MEMBERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Cracks:**			
Observation:			
a. Hairline or greater crack, fillet of top flange.	LF		3
***{Severity H}			
b. Hairline or greater crack, fillet of bottom flange.	LF		3
***{Severity H}			
c. Hairline or greater vertical crack, in web of beam.	LF		3
***{Severity H}			
Defect:			
*** Cracks - Attachment Welds:** Check all vertical and longitudinal stiffener welds for cracks.			
Observation:			
a. Hairline or greater crack, at toe of weld or adjacent metal.	LF		3
***{Severity H}			
Defect:			
*** Straightness or Buckling:**			
Observation:			
a. Sign of wrinkles in web and or stiffener plate at support.	LF		
***{Severity M}			
b. Sign of wrinkles in flange.	LF		
***{Severity M}			
c. Sign of buckling in web and or stiffener plate at support.	LF		3
***{Severity H}			
d. Sign of buckling in flange.	LF		3
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ **16.04.03 STEEL PRIMARY AND SECONDARY MEMBERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Support Ends:**			
Observation:			
a. Slight wrinkles in web or flanges.	LF		
***{Severity M}			
b. Sign of buckling in web or flanges.	LF		3
***{Severity H}			
Defect:			
*** Vehicular Damage:**			
Observation:			
a. Primary member out of alignment.	LF		3
***{Severity H}			
b. Secondary member out-of alignment.	LF		3
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ 16.04.04 CONNECTIONS

Joint and connections for steel beams, diaphragm and cross frame may be either welded, bolted, riveted, or pinned.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion - Gussets or Connection Plates:**			
Observation:			
a. Surface rust no pitting evident.	SF		
***{Severity L)			
b. Corrosion evident pitting and blistering of base material.	SF		
***{Severity M)			
c. Corrosion evident with loss to base section.	SF		4
***{Severity H}			
Defect:			
*** Corrosion - Bolts or Welds:**			
Observation:			
a. Surface rust no pitting evident.	EA		
***{Severity L)			
b. Corrosion evident pitting and blistering of base material.	EA		
***{Severity M)			
c. Corrosion evident with loss to base section.	EA		4
***{Severity H}			
Defect:			
*** Connectors or Fasteners:**			
Observation:			
a. Loose bolts or fasteners.	EA		
***{Severity L}			
b. Missing fasteners or connectors.	EA		
***{Severity H}			
c. Crack in weld.	LF		4
***{Severity H}			
d. Crack in connection plate.	LF		4
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ 16.04.05 BEARINGS

A bridge bearing is a superstructure element which provides an interface between the superstructure and the substructure. The three primary functions of a bearing are:

1. To transmit all the dead and live loads from the superstructure.
2. To permit longitudinal movement of the superstructure due to thermal expansion and contraction.
3. To allow rotation caused by dead and live loads deflection.

Bearings that do not allow for translation or movement of the superstructure are referred to as fixed bearings. Bearings that do allow for translation or movement of the superstructure are known as expansion bearings. A bridge bearing consists of four basic parts which includes, sole plate, bearing or bearing surfaces, masonry plate and anchorage. Various expansion bearing types have evolved out of the need to accommodate superstructure movement.

Potential defects which may be observed include, corrosion, rotation and excess movement.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Metal Bearing - Expansion or Fixed Bearing:**			
Observation:			
a. Surface rust no evidence of pitting, expansion bearing free to rotate.	EA		
***{Severity L}			
b. Dirt and debris accumulated around base of bearing.	SF		
***{Severity L}			
c. Corrosion pitting and Blistering of base metal, expansion bearing free to rotate.	EA		
***{Severity M}			
d. Corrosion with loss to base section, expansion bearing frozen.	EA		5
***{Severity H}			
e. Excess rotation of expansion bearing.	EA		5
***{Severity H}			
f. Loss of bearing area due to lateral or longitudinal movement.	EA		5
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ **16.04.05 BEARINGS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Elastomeric Bearing:**			
Observation:			
a. Bulging of the bearing.	EA		5
***{Severity M}			
b. Splitting or tearing of the bearing, including interior steel shims bond.	EA		5
***{Severity M}			
c. Bond to the sole and or masonry plate failed.	EA		5
***{Severity H}			
d. Excess longitudinal movement.	EA		5
***{Severity H}			
e. Excess rotation movement.	EA		5
***{Severity H}			
f. Loss of bearing area due to lateral or longitudinal movement.	EA		5
***{Severity H}			
Defect:			
*** Pin and Link Bearing:**			
Observation:			
a. Surface rust no pitting evident, joint free to rotate.	EA		
***{Severity L)			
b. Corrosion evident pitting and blistering of base material.	EA		
***{Severity M)			
c. Corrosion evident with loss to base section, joint frozen.	EA		5
***{Severity H}			

16.04 SUPERSTRUCTURE

COMPONENTS (Continued)

◆ **16.04.05 BEARINGS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion - Sole and Masonry Plates:**			
Observation:			
a. Surface rust no pitting evident.	SF		
***{Severity L)			
b. Corrosion evident pitting and blistering of base material.	SF		
***{Severity M)			
c. Corrosion evident with loss to base section.	SF		5
***{Severity H}			
Defect:			
*** Anchor Bolts:**			
Observation:			
a. Surface rust no pitting evident.	EA		
***{Severity L}			
b. Loose anchor bolts, nuts or bearing.	EA		
***{Severity L}			
c. Corrosion evident pitting and blistering of base material.	EA		
***{Severity M}			
d. Corrosion evident with loss to base section.	EA		5
***{Severity H}			
e. Missing or broken anchor bolts.	EA		5
***{Severity H}			

16.04 SUPERSTRUCTURE

REFERENCES

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition.

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.04 SUPERSTRUCTURE

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 16.04.01-1
2	GS-II 16.04.02-2

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 16.04.01-1
2	GS-III 16.04.02-2
3	GS-III 16.04.03-3
4	GS-III 16.04.04-4
5	GS-III 16.04.05-5

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: TIMBER PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-II 16.04.01-1

Application

This applies to the investigation of possible interior and exterior deterioration of timber primary and secondary members due to decay (rot), or parasites.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the Level II.

Inspection Actions

1. Clean affected area.
2. Measure affected area.
3. Tap with hammer to determine extend of hollow or sound material.
4. Probe with ice pick.

Recommended inspection Frequency

As triggered by Level I defect/observation, and where this Level II inspection is the standard inspection procedure.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: CONCRETE PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-II 16.04.02-2

Application

This applies to the investigation of concrete deterioration to primary and secondary members due to spalling from delamination.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the level II.

Inspection Actions

1. Clean loose concrete from area to be inspected.
2. Measure the affected area.
3. Tap the affected area with a hammer to determine extent of unsound or hollow concrete.

Recommended Inspection Frequency

As triggered by Level I defect/observation, and where this Level II inspection is the standard inspection procedure.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete
5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: TIMBER PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.01-1

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at the timber primary and secondary members.

Whereas the purpose of the Level I inspection was to record the observable defects on the primary and secondary members, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the bridge and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridge superstructure.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.01-1

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the timber primary and secondary members the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance,or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bridge superstructure.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for primary and secondary members include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.01-1

Advanced Test or Inspection Method		Applicable Observed Defects
1.	Increment borer	interior and exterior deterioration of timber due to decay or parasites
2.	Moisture content	deterioration due to decay or parasites
3.	Ultrasonic testing	splits and internal flaws
4.	Survey measurements	members out-of-alignment

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Increment borer
Survey level and rod
Navigable boat with related safety equipment
Moisture meter
Ultrasonic testing

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: CONCRETE PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.02-2

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at the concrete primary and secondary members.

Whereas the purpose of the Level I inspection was to record the observable defects on the primary and secondary members, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the primary and secondary members and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridge superstructure.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.02-2

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the primary and secondary members and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance,or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bridge superstructure.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for primary and secondary members include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.02-2

	Advanced Test or Inspection Method	Applicable Observed Defects
1.	Infrared Thermography and ground probing radar	concrete spalling and delamination
2.	Concrete coring	concrete deterioration
3.	Laboratory test on concrete (core, strength tests, abrasion, absorption,sulfate soundness, unit weight	concrete deterioration and strength
4.	Ultrasonic test	internal cracks and spalling, delamination
5.	Half-cell test	corrosion to reinforcement steel
6.	Survey measurements	member out-of-alignment

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Industry required testing equipment needed to perform the advanced investigation method chosen.
Navigable boat with related safety equipment.
Surveying equipment

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CONCRETE PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.02-2

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: STEEL PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.03-3

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at the steel primary and secondary members.

Whereas the purpose of the Level I inspection was to record the observable defects at the primary and secondary members, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the primary and secondary member and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the primary and secondary members.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: STEEL PRIMARY AND SECONDARY MEMBERS
CONTROL NUMBER: GS-III 16.04.03-3

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the primary and secondary members and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bridge superstructure.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for primary and secondary members include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: STEEL PRIMARY AND SECONDARY MEMBER
CONTROL NUMBER: GS-III 16.04.03-3

	Advanced Test or Inspection Method	Applicable Observed Defects
1.	Grinding and or sandblasting, using caliper to measure section loss	corrosion of steel and section loss
2.	Magnetic particle	cracks in steel or welds
3.	Dye-Penetrant	cracks in steel or welds
3.	Ultrasonic test	cracks and voids in steel
4.	Survey measurements	member out-of-alignment

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Grinder or sandblasting equipment
Surveying equipment
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4

COMPONENT: CONNECTIONS
CONTROL NUMBER: GS-III 16.04.04-4

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at the connection.

Whereas the purpose of the Level I inspection was to record the observable defects at the connections, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the superstructural and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridges.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: CONNECTIONS
CONTROL NUMBER: GS-III 16.04.04-4

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the connections and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bridge superstructure.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for bridge superstructure include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: CONNECTIONS
CONTROL NUMBER: GS-III 16.04.04-4

	Advanced Test or Inspection Method	Applicable Observed Defects
1.	Grinding and or sandblasting, using caliper to measure section loss	corrosion of steel and section loss
2.	Magnetic particle	cracks in steel or welds
3.	Dye-Penetrant	cracks in steel or welds
3.	Ultrasonic test	cracks and voids in steel

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Grinder or sandblaster equipment
Surveying equipment
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: BEARINGS
CONTROL NUMBER: GS-III 16.04.05-5

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at the bearings.

Whereas the purpose of the Level I inspection was to record the observable defects at the expansion joint, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the superstructural and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridge superstructure.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: BEARINGS
CONTROL NUMBER: GS-III 16.04.05-5

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the bearings and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bearings.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for the bearings include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: BEARINGS
CONTROL NUMBER: GS-III 16.04.05-5

Advanced Test or Inspection Method		Applicable Observed Defects
1.	Grinding or sandblasting, using caliper to measure section loss	corrosion of steel and section loss
2.	Magnetic particle	cracks in steel or welds
4.	Dye-Penetrant	cracks in steel or welds
5.	Ultrasonic test	cracks and voids in steel
6.	Survey measurements	bearing movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Grinder or sandblasting equipment
Surveying equipment
navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of Transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge Inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.05 BRIDGE DECKS

DESCRIPTION

The primary function of a bridge deck is to provide a roadway over or through the superstructure which traffic can move and distribute the live and dead loads to the superstructure. There are three common materials used; Timber, Concrete and Steel. The specific structural function of a deck is determined by whether the deck is composite or non-composite.

A composite deck is designed to join together the deck and supporting members such that they structurally behave as one member. A composite deck spans between its supports but also functions to increase the superstructure strength and allowable span length. Composite decks are often used in design, the most common application being the attachment of a deck to steel beams or girders.

A non-composite deck does not contribute to the structural capacity of the supporting members. A non-composite deck only functions to span between supporting members and to provide a wearing surface for the traffic.

Curb barriers which parallel the side limits of the bridge deck guide the movement of vehicle wheels and safeguard bridge trusses, railing or other construction existing outside the roadway limit. Pedestrian traffic on sidewalks are also protected from collision with vehicular traffic.

Some bridge decks provide deck area to serve pedestrian traffic only and, for safety and convenience to its users, these walkways are commonly elevated above the deck portion used by vehicles.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the standard Tool Section, may be required to preform the inspection of this subsystem:

1. Boat
2. Related safety equipment

SPECIAL SAFETY REQUIREMENTS

Level I and Level II inspection are performed by walking the bridge deck, and observing from ground level, thus passing traffic is a hazard. The inspection must be performed with prior approval of the Facility Manager, who will notify the necessary authorities so as to provide traffic safety measures and access. It is suggested that the inspector wear an orange safety vest.

Depending on the bridge type a boat may be required to observe certain components under the bridge deck. The inspector will take all necessary safety measures, and refer to the Master Safety Plan for guidance and compliance.

16.05 BRIDGE DECKS

COMPONENT LIST

- 16.05.01 ASPHALTIC WEARING SURFACE
- 16.05.02 TIMBER DECK
- 16.05.03 CONCRETE DECK
- 16.05.04 STEEL DECK
- 16.05.05 EXPANSION JOINTS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspecting, the following DS/IMs should be reviewed for concurred inspection activities.

19.01	ROADWAYS
20.01	RAILROAD
21.00	WATERFRONT (all subsystems)
29.00	SITE ELECTRICAL (all subsystems)

STANDARD INSPECTION PROCEDURE

The Level I inspection shall be carried out for each component in the order listed. The inspector will identify any physical defects existing in each component; will note the level of severity of each defect type; and measure the quantity of each defect. Both the top surface and underside shall be inspected.

16.05 BRIDGE DECKS

COMPONENTS

♦ 16.05.01 ASPHALTIC WEARING SURFACE

The wearing surface provides the riding surface for traffic and is placed on top of the structural deck. Wearing surfaces are either asphaltic concrete, portland cement or timber. A timber wearing surface may consist of longitudinal timber placed over the transverse decking.Timber wearing surface is often referred to as "Runner Boards" and are placed longitudinally only in the strip where the wheels of vehicles ride. When the wearing surface is concrete and poured simultaneously with the slab it is referred to as a monolithic deck.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Alligator or Fatigue Cracking:** When two or three levels of severity exist within one distressed area and if these can be easily distinguished from each other, they should be measured and recorded separately. However, if the different levels of severity cannot be easily divided, the entire area should be rated at the highest severity level present.			
Observation:			
a. Longitudinal disconnected hairline cracks running parallel to each other. The cracks are not spalled. Initially there may only be a single crack in the wheel path.	SF		1
*** {Severity L}			
b. Further development of low severity alligator cracking into a pattern of pieces formed by cracks that may be lightly surface-spalled.	SF		1
*** {Severity M}			
c. Medium alligator cracking has progressed so that pieces are more severely spalled at the edges and loosened until the cells rock under traffic. Pumping may also exist.	SF		1
*** {Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.01 ASPHALTIC WEARING SURFACE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Asphalt Bleeding:**			
Observation:			
a. Bleeding has only occurred to a very slight degree and it is noticeable only during a few days a year. Asphalt does not stick to shoes or vehicles.	SF		
*** {Severity L}			
b. Bleeding has occurred to the extent that asphalt sticks to shoes and vehicles during only a few weeks of the year.	SF		
*** {Severity M}			
c. Bleeding has occurred extensively and considerable asphalt sticks to shoes and vehicles during at least several weeks of the year.	SF		
*** {Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.01 ASPHALTIC WEARING SURFACE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Block Cracking**			
Observation:			
a. Blocks are defined by non-sealed cracks that are non-spalled (sides of the crack are vertical) or only minor spalling with a ¼-inch or less mean width.	SF		
***{Severity L}			
b. Blocks are defined by sealed cracks that have a sealant in satisfactory condition to prevent moisture infiltration.	SF		
***{Severity L}			
c. Blocks are defined by sealed or non-sealed cracks that are moderately spalled.	SF		1
***{Severity M}			
d. Blocks are defined by non-sealed cracks that are not spalled or have only minor spalling, but have a mean width greater than approximately 1/4-inch.	SF		
***{Severity M}			
e. Blocks are defined by sealed cracks that are not spalled or have only minor spalling, but have sealant in unsatisfactory condition to prevent moisture infiltration.	SF		
***{Severity M}			
f. Blocks are well defined by cracks that are severely spalled.	SF		
*** {Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.01 ASPHALTIC WEARING SURFACE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Edge Cracking:**			
Observation:			
a. Low or medium severity cracking with no breakup or raveling.	SF		
***{Severity L}			
b. Medium severity cracks with some breakup or raveling.	SF		
***{Severity M}			
c. Considerable breakup or raveling along the edge. Broken pieces may be removable.	SF		1
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ 16.05.01 ASPHALTIC WEARING SURFACE (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Longitudinal and Transverse Cracking:** The vehicle used to determine bump severity is a mid- to full-size sedan weighing approximately 3,000 to 3,800 lb. over the pavement inspection unit at the posted speed limit.			
Observation:			
a. Non-sealed cracks have either minor spalling or no spalling; the cracks have a mean width of ¼-inch or less.	LF		
*** {Severity L}			
b. Sealed cracks have either minor spalling or no spalling; cracks are of any width, but their sealant material is in satisfactory condition to substantially prevent water infiltration.	LF		
*** {Severity L}			
c. No significant bump occurs when a vehicle crosses the crack.	LF		
*** {Severity L}			
d. Cracks are moderately spalled and can be either sealed or non-sealed of any width.	LF		
*** {Severity M}			
e. Sealed cracks are not spalled or have only minor spalling, but the sealant is in a condition so that water can freely infiltrate.	LF		
*** {Severity M}			
f. Non-sealed cracks are not spalled or are only lightly spalled, but the mean crack width is greater than 1/4-inch.	LF		
*** {Severity M}			
g. Low-severity random cracking exists near the crack or at the corners of intersecting cracks.	LF		
*** {Severity M}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ 16.05.01 ASPHALTIC WEARING SURFACE (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Longitudinal and Transverse Cracking (Continued)**			
h. The crack causes a significant bump to a vehicle.	LF		
***{Severity M}			
i. Cracks are severely spalled and/or there exists medium or high random cracking near the crack or at the corners of intersecting cracks.	LF		1
***{Severity H}			
j. The crack causes a severe bump to a vehicle.	LF		1
***{Severity H}			

Defect:

*** Patch Deterioration:**
The vehicle used to determine patch condition severity is a mid- to full-size sedan weighing approximately 3,000 to 3,800 lb. over the pavement inspection unit at the posted speed limit.

Observation:			
a. Patch is in very good condition and is performing satisfactorily.	SF		
***{Severity L}			
b. Patch is somewhat deteriorated, having low to medium levels of any types of distress.	SF		
***{Severity M}			
c. The patch causes a significant bump to a vehicle.	SF		
***{Severity M}			
d. Patch is badly deteriorated and soon needs replacement.	SF		
***{Severity H}			
e. The patch causes a severe bump to a vehicle.	SF		
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.01 ASPHALTIC WEARING SURFACE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Polished Aggregate:** The existence of polishing can be detected by both visually observing and running the fingers over the surface.			
Observation:			
a. Aggregate extending above the pavement is negligible, and the surface aggregate is smooth to the touch.	SF		
***{Severity L}			
b. Pavement surface is smooth and has a distinctive dull finish.	SF		
***{Severity M}			
c. Pavement surface appears highly smooth and the aggregate are highly polished.	SF		1
***{Severity H}			

Defect:

*** Potholes:**

Observation:			
a. Pothole area up to 3 SF and depth less than 1 inch.	SF		
***{Severity L}			
b. Pothole area up to 3 SF and depth between 1 and 2 inches.	SF		
***{Severity M}			
c. Pothole area more than 3 SF and depth less than 1 inch.	SF		
***{Severity M}			
d. Pothole area less than 1 SF and depth more than 2 inches.	SF		
***{Severity M}			
e. Pothole area between 1 and 3 SF and depth more than 2 inches.	SF		
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.01 ASPHALTIC WEARING SURFACE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Reflection Cracking** The vehicle used to determine bump is a mid to full-size sedan weighing approximately 3,000 to 3,800 lbs. over the pavement inspection unit at the posted speed limit.			
Observation:			
a. Cracks have either minor spalling or no spalling. Non-sealed cracks have a mean width of ¼-inch or less.	LF		
***{Severity L}			
b. Cracks have either minor spalling or no spalling. Cracks are sealed and of any width, both their sealant material is in satisfactory condition to substantially prevent water infiltration.	LF		
***{Severity L}			
c. No significant bump occurs when a vehicle crosses the crack.	LF		
***{Severity L}			
d. Cracks are moderately spalled and can be either sealed or non-sealed of any width.	LF		
***{Severity M}			
e. Sealed cracks are not spalled or have only minor spalling, but the sealant is in a condition so that water can freely infiltrate.	LF		
***{Severity M}			
f. Non-sealed cracks are not spalled or are only lightly spalled, but the mean crack width is greater than ¼-inch.	LF		
***{Severity M}			
g. Low-severity random cracking exists near the crack or at the corners of intersecting cracks.	LF		
***{Severity M}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.01 ASPHALTIC WEARING SURFACE (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Reflection Cracking (Continued)**			
h. The crack causes a significant bump to a vehicle.	LF		
***{Severity M}			
i. Cracks are severely spalled and/or there exists medium or high random cracking near the crack or at the corners of intersecting cracks.	LF		
***{Severity H}			
j. The crack causes a severe bump to a vehicle.	LF		
***{Severity H}			
Defect:			
*** Rutting:**			
Rutting severity is determined by the mean depth of the rut. To determine the mean depth, a 4-foot straight edge should be laid across the rut and the maximum depth measured. The mean depth should be computed from measurements taken every 20 feet along the length of the rut.			
Observation:			
Mean Rut Depth Criteria			
a. ¼ - ½ in.	SF		
***{Severity L}			
b. Between ½ - 1 in.	SF		1
***{Severity M}			
c. Greater than 1 in.	SF		1
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS

◆ 16.05.02 TIMBER DECK

The primary function of a bridge deck is to provide a roadway over which traffic can move and to distribute live and dead loads to the superstructure. On some bridge decks sidewalk and curbs are provided and are considered part of the bridge deck. The three most common materials used in construction of bridge decks are timber, concrete and steel deck.

The potential defect which may be observed in timber decks include decay, parasites, deterioration, weathering and overloads.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Weathering and Wear:**			
Observation:			
a. Surface of wood is rough and corrugated and member may be warped.	SF		
***{Severity L}			
b. Surface of wood is rough and corrugated with cracks partially through the wood member, may have minor section loss to the top surface. Member may be warped.	SF	1	
***{Severity M}			
c. Large cracks extend deeply or completely through the wood.	SF		2
***{Severity H}			
d. Wood is crumbly and seriously deteriorated.	SF		2
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS

◆ **16.05.02 TIMBER DECK (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Deflection:**			
Observation:			
a. Slight deflection of member when vehicles pass.	LF		
***{Severity L}			
b. Noticeable deflection of member when vehicles pass.	LF		
***{Severity M}			
c. Large deflection of member when vehicles pass.	LF		2
***{Severity H}			
d. Permanent deformation of member.	LF		2
***{Severity H}			
Defect:			
*** Vibration - Per Span:**			
Observation:			
a. Slight vibration in deck when vehicles pass.	LF		
***{Severity L}			
b. Noticeable vibration in deck when vehicles pass.	LF		
***{Severity M}			
c. Excessive vibration in deck when vehicles pass.	LF		2
***{Severity H}			
Defect:			
*** Vehicular Damage:**			
Observation:			
a. Member out of alignment.	LF		3
***{Severity H}			
b. Shattered or injured timber member.	LF		3
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.02 TIMBER DECK (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Decay (Rot/Fungus Decay):** Decay from rot/fungus is most likely to occur at connections, splices, support points or around bolt holes. This may be due either to the tendency of such areas to collect and retain moisture, or to bolt holes or cuts being made in the surface after the preservative treatment has been applied.			
Observation:			
a. Moist and stain or discolored area signs of fungi, surface is solid.	SF		
***{Severity L}			
b. Surface spongy, member may show signs of crushing.	SF	1	
***{Severity M}			
c. Brown and white - discolored area, member may show section loss and crushing.	SF		2
***{Severity H}			

Defect:

*** Connections:**

Observation:			
a. Loose fasteners.	EA		
***{Severity M}			
b. Member broken, split or damaged.	EA		
***{Severity H}			
c. Missing fasteners or anchorage.	EA		
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.02 TIMBER DECK (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Parasites:** (Termites, carpenter ants, powder post beetles)			
Observation:			
a. Pinholes with dark stain area around the holes.	SF		
***{Severity L}			
b. Holes less than 1/8" diameter, surface sag, and sawdust observed.	SF	1	
***{Severity M}			
c. Holes greater than 1/8" diameter, surface channels, and crushing of the member.	SF		2
***{Severity H}			

Defect:

*** Deck Missing:**

Observation:			
a. Hole in deck.	SF		2
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ 16.05.03 CONCRETE DECK

Potential defects which may be observed on concrete decks include cracking, scaling, spalling, corrosion to reinforcement and overloads.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Wear and Abrasion (Top Surface):**			
Observation:			
a. Slight or noticeable dull finish to concrete surface.	SF		
***{Severity L}			
b. Distinctive dull finish to concrete surface.	SF		
***{Severity M}			
c. Glossy mirror finished to concrete surface.	SF		
***{Severity H}			
Defect:			
*** Transverse Cracks (Top Surface):**			
Observation:			
a. Hairline cracks less than 1/16" wide.	LF		
***{Severity L}			
b. Medium cracks greater than 1/16", less than 1/8" wide with spalling of cracks.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide with spalling of cracks and reinforcing bars exposed.	LF		3
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.03 CONCRETE DECK (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Longitudinal Cracks (Top Surface):**			
Observation:			
a. Hairline cracks less than 1/16" wide.	LF		
***{Severity L}			
b. Medium cracks greater than 1/16", less than 1/8" wide with spalling of cracks.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide with spalling of cracks and reinforcing bars exposed.	LF		3
***{Severity H}			
Defect:			
*** Transverse Cracks (Underside):**			
Observation:			
a. Hairline cracks less than 1/16" wide, slight staining of concrete surface.	LF		
***{Severity L}			
b. Medium cracks greater than 1/16" and less than 1/8" wide. Staining of concrete surface with signs of efflorescence deposits and spalling of crack.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposits, and spalling of crack and reinforcing bars exposed.	LF		3
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.03 CONCRETE DECK (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Longitudinal Cracks (Underside) :**			
Observation:			
a. Hairline cracks less than 1/16" wide, slight staining of concrete surface.	LF		
***{Severity L}			
b. Medium cracks greater than 1/16" less than 1/8" wide. Staining of concrete surface with sign of efflorescence deposits and spalling of crack.	LF	2	
***{Severity M}			
c. Wide cracks greater than 1/8" wide. Staining of concrete surface with efflorescence deposits, spalling of crack and reinforcing bars exposed.	LF		3
***{Severity H}			
Defect:			
*** Scaling:**			
Observation:			
a. Loss of surface mortar greater than 1/4" deep and less than 1/2" deep with exposed aggregate.	SF		
***{Severity L}			
b. Loss of surface mortar greater than 1/2" deep, less than 1" deep. Coarse aggregates are clearly exposed.	SF		
***{Severity M}			
c. Loss of coarse aggregate particles, as well as mortar surrounding coarse aggregates; depth of the loss greater than 1" deep, reinforcing bars exposed.	SF		
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.03 CONCRETE DECK (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Spalling:**			
Observation:			
a. Depression less than 1" deep and less than 6" in diameter.	SF		
***{Severity L}			
b. Depression greater than 1" deep and greater than 6" in diameter.	SF	2	
***{Severity M}			
c. Depression greater than 1" deep and greater than 6" in diameter with corroded reinforcing bars.	SF		3
***{Severity H}			

Defect:

*** Popout:**			
Observation:			
a. Conical shape holes less than 1/2" diameter.	SF		
***{Severity L}			
b. Conical shape hole greater than 1/2", less than 2-1/2" diameter.	SF		
***{Severity M}			
c. Conical shape hole greater than 2-1/2" in diameter.	SF		
***{Severity M}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.03 CONCRETE DECK (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Honeycombing:**			
Observation:			
a. Hollow spaces or voids present within concrete, aggregated partially exposed, concrete is sound around damage area.	SF		
***{Severity L}			
b. Hollow spaces or voids present within concrete with exposed aggregate, concrete is sound around defected area.	SF	2	
***{Severity M}			
c. Hollow spaces or voids present within concrete with exposed reinforcing bars.	SF		3
***{Severity H}			
Defect:			
* **Vibration - Per Span:**			
Observation:			
a. Slight vibration in deck when vehicles pass.	LF		
***{Severity L}			
b. Noticeable vibration in deck when vehicles pass.	LF		
***{Severity M}			
c. Excessive vibration in deck when vehicles pass.	LF		3
***{Severity H}			
Defect:			
* **Deck Missing:**			
Observation:			
a. Hole in deck.	SF		3
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ 16.05.04 STEEL DECK

The common types of steel decks are grid and corrugated steel flooring. Impervious wearing surfaces are often placed over the steel deck to protect the steel from weather and corrosion.

The potential defects which may be observed on steel deck include corrosion, wear, and vehicular damage.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Wear - No Wearing Surface:**			
Observation:			
a. Minor wear to the serrated bars or steel plate.	SF		
***{Severity L}			
b. Noticeable wear to the serrated bars or plate, surface slippery.	SF		
***{Severity M}			
Defect:			
*** Connections:**			
Observation:			
a. Loose bolts or fasteners.	EA		
***{Severity M}			
b. Broken or missing bolts, rivets.	EA		4
***{Severity H}			
c. Broken welds.	LF		4
***{Severity H}			
Defect:			
*** Corrosion - Grid Rails or Corrugated Steel Flooring:**			
Observation:			
a. Surface rust no pitting evident.	SF		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	SF		
***{Severity M}			
c. Corrosion evident with loss to base section.	SF		4
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.04 STEEL DECK (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damage Grid Rail and/or Transverse Bars:**			
Observation:			
a. Out of alignment or damaged member.	LF		
***{Severity M}			
b. Grid rail cracked.	LF		
***{Severity H}			
c. Broken or missing member.	LF		
***{Severity H}			
Defect:			
*** Vibration - Per Span:**			
Observation:			
a. Slight vibration in deck when vehicles pass.	LF		
***{Severity L}			
b. Noticeable vibration in deck when vehicles pass.	LF		
***{Severity M}			
c. Excessive vibration in deck when vehicles pass.	LF		4
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ 16.05.05 EXPANSION JOINTS

The primary function of the expansion joint is to accommodate the expansion and contraction of the bridge deck due to the thermal or other forces. The joint also fills the gap between the deck surface and the backwall. In addition, the deck joint provides a smooth transition from the approach roadway to the bridge deck. The joint opening size depends on the season, the type of expansion joint, the temperature range, and the length of slab whose expansion the joint must accommodate. There are two types of expansion joints, open and closed joints. The open joint, allows water and debris to pass through the joint where as the closed joint prevents water and debris from passing through the joint.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Joint Displacement:**			
Observation:			
a. Vertical displacement less than 1/4".	LF		
***{Severity L}			
b. Vertical displacement greater than 1/4", less than 1/2".	LF		
***{Severity M}			
c. Vertical displacement greater than 1/2".	LF		5
***{Severity H}			

Defect:

*** Joint Horizontal Clearance:**
The proper joint opening size depends on the season, the type of expansion joint, the temperature range, and the length of the slab whose expansion the joint must accommodate.

Observation:			
a. Joint opening less than 3".	LF		
***{Severity M}			
b. Joint completely closed	LF		5
***{Severity H}			
c. Joint opening greater than 4".	LF		5
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.05 EXPANSION JOINTS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Finger Plate:**			
Observation:			
a. Loose finger plate.	LF		5
***{Severity M}			
b. Jammed fingers.	LF		5
***{Severity M}			
c. Fingers do not lap.	LF		5
***{Severity H}			
d. Broken or cracked joint finger.	EA		5
***{Severity H}			
e. Broken fasteners or welds.	EA		5
***{Severity H}			
Defect:			
* **Corrosion, Expansion or Armor Plates:**			
Observation:			
a. Surface rust no pitting evident.	SF		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	SF		
***{Severity M}			
c. Corrosion evident with loss to base section.	SF		5
***{Severity H}			

16.05 BRIDGE DECKS

COMPONENTS (Continued)

◆ **16.05.05 EXPANSION JOINTS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Joint Seal Damage:**			
Observation:			
a. Joint sealant is in good condition throughout the section, allowing little water and no incompressible material to infiltrate through the joint.	LF		
***{Severity L}			
b. Joint condition is fair throughout the section. Water can infiltrate the joint fairly easily and some incompressible materials can infiltrate the joint.	LF		
***{Severity M}			
c. Joint sealant is in poor condition throughout the section. Water and incompressible material can freely infiltrate the joint.	LF		5
***{Severity H}			
Defect:			
*** Sliding Plate:**			
Observation:			
a. Loose sliding plates or anchor.	LF		
***{Severity M}			
b. Jammed slide plate.	LF		
***{Severity M}			
c. Bent or cracked sliding plate.	LF		5
***{Severity H }			
d. Broken fasteners or welds.	EA		5
***{Severity H }			
Defect:			
*** Indiscriminate Overlay:**			
Observation:			
a. New pavement or wearing surface over existing deck joint.	SF		
***{Severity H}			

16.05 BRIDGE DECKS

REFERENCES

1. U.S. Department of Transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge Inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

7. AASHTO Guide for Design of Pavement Structures, 1986

8. TM 5-623, Pavement Maintenance Management, November 1982

9. Principals of Pavement Design, E. J. Yoder, John Wiley & Sons, Inc.

10. Micro PAVER, User's Guide, Version 3.0, U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, January 1992

16.05 BRIDGE DECKS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 16.05.01-1
2	GS-II 16.05.02-2

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 16.05.01-1
2	GS-III 16.05.02-2
3	GS-III 16.05.03-3
4	GS-III 16.05.04-4
5	GS-III 16.05.05-5

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: TIMBER DECK
CONTROL NUMBER: GS-II 16.05.02-1

Application

This applies to the investigation of possible interior and exterior deterioration of timber deck members due to decay (rot), or parasites.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the Level II.

Inspection Actions

1. Clean affected area.
2. Measure affected area.
3. Tap with hammer to determine extend of hollow or sound material.
4. Probe with ice pick.

Recommended inspection Frequency

As triggered by Level I or Level II defect/observation.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public Roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: CONCRETE DECK
CONTROL NUMBER: GS-II 16.05.03-2

Application

This applies to the investigation of concrete bridge deck deterioration due to spalling from delamination.

The results of the Level II inspection can be used to trigger a level III inspection or necessary repair.

Special Safety Requirements

No special Safety Requirements, beyond the requirements listed in the Safety Section, are to be observed in the performance of the level II.

Inspection Actions

1. Clean loose concrete from area to be inspected.
2. Measure the affected area.
3. Tap the affected area with a hammer to determine extent of unsound or hollow concrete.

Recommended Inspection Frequency

As triggered by Level I or Level II defect/observation

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition
2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993
3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991
4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete
5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials
6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: ASPHALTIC WEARING SURFACE
CONTROL NUMBER: GS-III 16.05.01-1

Application

This guide applies to investigation and testing of asphaltic wearing surface, to determine their structural capacity and to perform maintenance.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

Inspection Actions

Results of Level I inspection yield a measure of surface integrity of the pavement surfaces. Although Level I inspection methodology is very useful for maintaining the pavement systems of the base, its analysis however, cannot determine structural capacity of the pavement. When the pavement condition dictates that its rehabilitation may be required, then a more extensive Level III Inspection is essential. Level III requires the use of a more advanced method of testing includes techniques to measure pavement deflection, and advanced testing of one or more pavement components to determine component properties and strength. This equipment includes:

- Benkleman Beam
- Dynaflect
- Falling Weight Deflectometer
- Skid Resistance testing

These techniques can be used to detect voids under the pavement by the use of Ground Penetrating Radar equipment. Advanced techniques include sample coring through concrete or asphalt pavements to determine thickness, strength, and composition.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: ASPHALTIC WEARING SURFACE
CONTROL NUMBER: GS-III 16.05.01-1

Special Tools and Equipment

Standard testing equipment required to perform the advanced method testing and inspection

Recommended Inspection Frequency

As triggered by Level I or Level II defect/observation

References

1. AASHTO Guide for Design of Pavement Structures, 1986
2. TM 5-623, Pavement Maintenance Management, November 1982
3. Principals of Pavement Design, E. J. Yoder, John Wiley & Sons, Inc.
4. Micro PAVER, User's Guide, Version 3.0, U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, January 1992
5. ASTM D 5340 - 93, Standard Test Method for Airport Pavement Condition Index Surveys
6. TM 5-826-6/ AFR 93-5, Procedures for US Army and US Air Force Airfield Condition Surveys, July 1989

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: TIMBER DECK
CONTROL NUMBER: GS-III 16.05.02-2

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations on a timber deck.

Whereas the purpose of the Level I inspection was to record the observable defects on the timber deck, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the structural deck and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridge deck.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: TIMBER DECK
CONTROL NUMBER: GS-III 16.05.02-2

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the deck and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bridge deck.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for bridge deck include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: TIMBER DECK
CONTROL NUMBER: GS-III 16.05.02-2

Advanced Test or Inspection Method	Applicable Observed Defects
1. Increment borer	interior and exterior deterioration of timber due to decay or parasites
2. Ultrasonic	interior deterioration
3. Moisture content	deterioration due to decay or parasites
4. Survey measurements	deck movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Increment borer
Surveying equipment
Navigable boat with related safety equipment
Moisture meter

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: CONCRETE DECK
CONTROL NUMBER: GS-III 16.05.03-3

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations on a concrete deck.

Whereas the purpose of the Level I inspection was to record the observable defects on the deck, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the structural deck and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridge deck.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: CONCRETE DECK
CONTROL NUMBER: GS-III 16.05.03-3

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the concrete deck and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance,or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bridge deck.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for bridge deck include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: CONCRETE DECK
CONTROL NUMBER: GS-III 16.05.03-3

Advanced Test or Inspection Method	Applicable Observed Defects
1. Infrared Thermography and ground probing radar	concrete spalling and delamination
2. Concrete coring	concrete deterioration, cracking, spalling
3. Laboratory test on concrete (core, strength tests, abrasion, absorption,sulfate soundness, unit weight	concrete deterioration and strength
4. Ultrasonic test	internal cracks and spalling, delamination
5. Half-cell test	corrosion to reinforcement steel
6. Survey measurements	deck movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Industry required testing equipment needed to perform the advanced investigation method chosen.
Navigable boat with related safety equipment.
Surveying equipment

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: CONCRETE DECK
CONTROL NUMBER: GS-III 16.05.03-3

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4

COMPONENT: STEEL DECK
CONTROL NUMBER: GS-III 16.05.04-4

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations on a steel deck.

Whereas the purpose of the Level I inspection was to record the observable defects at the expansion joint, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the structural deck and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridge deck.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: STEEL DECK
CONTROL NUMBER: GS-III 16.05.04-4

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the steel deck and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records,water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bridge deck.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for bridge deck include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4 (Continued)

COMPONENT: STEEL DECKS
CONTROL NUMBER: GS-III 16.05.04-4

Advanced Test or Inspection Method	Applicable Observed Defects
1. Grinding and or sandblasting, using caliper to measure section loss	corrosion of steel and section loss
2. Magnetic particle	cracks in steel or welds
3. Dye-Penetrant	cracks in steel or welds
4. Ultrasonic	cracks and voids in steel
5. Survey measurements	deck movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Grinder or sand blasting equipment
Surveying equipment
Navigable boat with related safety equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: EXPANSION JOINTS
CONTROL NUMBER: GS-III 16.05.05-5

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations at the expansion joint.

Whereas the purpose of the Level I inspection was to record the observable defects at the expansion joint, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the expansion joints and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the expansion joint.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: EXPANSION JOINTS
CONTROL NUMBER: GS-III 16.05.05-5

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the expansion joints and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the expansion joint.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for expansion joint include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: EXPANSION JOINTS
CONTROL NUMBER: GS-III 16.05.05-5

Advanced Test or Inspection Method	Applicable Observed Defects
1. Grinding or sandblasting, using caliper to measure section loss	corrosion of steel and section loss
2. Magnetic particle	cracks in steel or welds
3. Dye-Penetrant	cracks in steel or welds
4. Ultrasonic test	cracks and voids in steel
5. Soil boring	Settlement of substructure
6. Survey measurements	deck movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Navigable boat with related safety equipment
Surveying equipment
Grinder or sand blaster equipment
Industry required testing equipment needed to perform the advanced investigation method chosen

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.06 BRIDGE RAILING AND PARAPETS

DESCRIPTION

The bridge railing or parapets is a fence-like construction built at the outer most edge of the roadway or sidewalk portion of a bridge. The primary function of the bridge railing or parapet is safety, to keep errant vehicles from driving off the edge of the bridge and to guard and guide the movement of pedestrian traffic. Bridge railing must also smoothly redirect the vehicle in such a manner that the vehicle does not overturn and the railing does not fail.

On older steel or timber bridge railing consisted of timber planks nailed together in a picket fence like arrangement. More recently, railings are made of steel angles, welded steel tubing or "W" shape rail supported by a wide flange post replacing the timber railing. Solid concrete parapet with steel or aluminum railing attached to the top are also commonly used today.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the Standard Tools Section, may be required to perform the inspection of this subsystem:

1. Boat
2. Related safety equipment

SPECIAL SAFETY REQUIREMENTS

Level I and Level II inspection is performed by walking the bridge deck, and observing from ground level, thus passing traffic is a hazard. The inspection must be performed with the prior approval of the Facility Manager, who will notify the necessary authorities to provide traffic safety measures and access. Inspector will be required to wear orange safety vest.

Depending on the bridge type a boat may be required to observe certain components. Inspectors are required to take all necessary safety measures, and refer to the Master Safety Plan for guidance and compliance.

COMPONENT LIST

- 16.06.01 TIMBER RAILING AND POST
- 16.06.02 CONCRETE PARAPETS
- 16.06.03 STEEL RAILING AND POST

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

19.01	ROADWAYS
20.01	RAILROAD
29.00	SITE ELECTRICAL (all subsystems)

STANDARD INSPECTION PROCEDURE

The Level I inspection shall be carried out for each component in the order listed. The inspector will identify any physical defects existing in each component; will note the level of severity of each defect type; and measure the quantity of each defect.

16.06 BRIDGE RAILING AND PARAPETS

COMPONENTS

◆ 16.06.01 TIMBER RAILING AND POST

The potential defects which may be observed in timber railing include decay, parasite damage and deterioration from weather and vehicle damage.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Weathering:**			
Observation:			
a. Surface of wood is rough and corrugated and member may be warped.	LF		
***{Severity L}			
b. Surface of wood is rough and corrugated with cracks partially through the wood member, may have minor section loss. Member may be warped.	LF		
***{Severity M}			
c. Large cracks extend deeply or completely through the wood.	LF		
***{Severity H}			
d. Wood is crumbly and seriously deteriorated.	LF		1
***{Severity H}			

Defect:

*** Decay (Rot/Fungus Decay):**
Decay from rot/fungus is most likely to occur at connections, splices, support points or around bolt holes. This may be due either to the tendency of such areas to collect and retain moisture, or to bolt holes or cuts being made in the surface after the preservative treatment has been applied.

Observation:			
a. Moist and stained or discolored area, signs of fungi, surface is solid.	LF		
***{Severity L}			
b. Surface spongy, member may shown signs of crushing	LF		
***{Severity M}			
c. Brown and white - discolored area, member may show section loss and crushing.	LF		
***{Severity H}			

16.06 BRIDGE RAILING AND PARAPETS

COMPONENTS (Continued)

◆ **16.06.01 TIMBER RAILING AND POST (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Parasites:** (Termites, carpenter ants, powder post beetles)			
Observation:			
a. Pinholes with dark stain area around the holes.	LF		
***{Severity L}			
b. Holes less than 1/8" diameter, surface sag, and sawdust observed.	LF		
***{Severity M}			
c. Holes greater than 1/8" diameter, surface channels, and crushing of the member.	LF		1
***{Severity H}			
Defect:			
*** Post Connections:**			
Observation:			
a. Loose fasteners.	EA		
***{Severity L}			
b. Broken, split or damaged.	EA		
***{Severity H}			
c. Missing fasteners or anchorage.	EA		
***{Severity H}			
Defect:			
*** Corrosion at Post Anchors:**			
Observation:			
a. Surface rust no pitting evident.	EA		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	EA		
***{ severity M}			
c. Corrosion evident with loss to base section.	EA		
***{Severity H}			

16.06 BRIDGE RAILING AND PARAPETS

COMPONENTS (Continued)

◆ **16.06.01 TIMBER RAILING AND POST (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Vehicular Damage:**			
Observation:			
a. Railing out of alignment.	LF		
***{Severity M}			
b. Post out of alignment.	LF		
***{Severity M}			
c. Railing shattered or damaged.	LF		
***{Severity H}			
d. Post shattered or damaged member.	LF		
***{Severity H}			
Defect:			
*** Vertical Joint Displacement:**			
Due to substructure or bearing settlement.			
Observation:			
a. Displacement less than 1/4".	EA		
***{Severity L}			
b. Displacement greater than 1/4" less than 1/2".	EA		
***{Severity M}			
c. Displacement greater than 1/2".	EA		
***{Severity H}			
Defect:			
*** Horizontal Joint Misalignment:**			
Due to substructure or bearing settlement.			
Observation:			
a. Displacement less than 1/4".	EA		
***{Severity L}			
b. Displacement greater than 1/4", less than 1/2".	EA		
***{Severity M}			
c. Displacement greater than 1/2".	EA		
***{Severity H}			

16.06 BRIDGE RAILING AND PARAPETS

COMPONENTS (Continued)

◆ 16.06.02 CONCRETE PARAPETS

Potential defects which may be observed include collision damage and deterioration to the concrete surfaces.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Horizontal Cracks:**			
Observation:			
a. Hairline cracks less than 1/16" wide, slight staining of concrete.	LF		
***{Severity L}			
b. Medium crack greater than 1/16, less than 1/8" wide with spalling along each side of crack. Staining of concrete surface.	LF		
***{Severity M}			
c. Wide cracks greater than 1/8" wide, with spalling each side of cracks with reinforcing bars exposed	LF		
***{Severity H}			
Defect:			
*** Vertical Cracks:**			
Observation:			
a. Hairline cracks less than 1/16" wide, slight staining of concrete.	LF		
***{Severity L}			
b. Medium cracks greater than 1/16", less than 1/8" wide with spalling of cracks and staining of concrete surface.	LF		
***{Severity M}			
c. Wide cracks greater than 1/8" wide with spalling of cracks and reinforcing bars exposed.	LF		
***{Severity H}			

16.06 BRIDGE RAILING AND PARAPETS

COMPONENTS (Continued)

♦ 16.06.02 CONCRETE PARAPETS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Scaling:**			
Observation:			
a. Loss of surface mortar greater than 1/4" deep and less than 1/2" deep with exposed aggregate.	SF		
***{Severity L}			
b. Loss of surface mortar greater than 1/2" deep, less than 1" deep. Coarse aggregates are clearly exposed.	SF		
***{Severity M}			
c. Loss of coarse aggregate particles, as well as mortar surrounding coarse aggregates; depth of the loss greater than 1" deep, reinforcing bars exposed.	SF		
***{Severity H}			
Defect:			
*** Spalling:**			
Observation:			
a. Depression less than 1" deep and less than 6" in diameter.	SF		
***{Severity L}			
b. Depression greater than 1" deep and greater than 6" in diameter.	SF		
***{Severity M}			
c. Depression greater than 1" deep and greater than 6" in diameter with corroded re-bars.	SF		
***{Severity H}			
Defect:			
*** Popout:**			
Observation:			
a. Conical shape holes less than 1/2" diameter.	SF		
***{Severity L}			
b. Conical shape Hole greater than 1/2" less than 2-1/2" diameter.	SF		
***{Severity M}			
c. Conical shape hole greater than 2-1/2" in diameter.	SF		
***{Severity M}			

16.06 BRIDGE RAILING AND PARAPETS

COMPONENTS (Continued)

◆ **16.06.02 CONCRETE PARAPETS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
Defect:			
*** Vehicular Damage:**			
Observation:			
a. Member out of alignment.	LF		
***{Severity H}			
b. Shattered or major damage to member.	LF		
***{Severity H}			
Defect:			
*** Vertical Joint Displacement:**			
Due to substructure or bearing settlement.			
Observation:			
a. Displacement less than 1/4".	EA		
***{Severity L}			
b. Displacement greater than 1/4", less than 1/2".	EA		
***{Severity M}			
c. Displacement greater than 1/2".	EA		
***{Severity H}			
Defect:			
*** Horizontal Joint Misalignment:**			
Due to substructure or bearing settlement.			
Observation:			
a. Displacement less than 1/4".	EA		
***{Severity L}			
b. Displacement greater than 1/4", less than 1/2".	EA		
***{Severity M}			
c. Displacement greater than 1/2".	EA		
***{Severity H}			

16.06 BRIDGE RAILING AND PARAPETS

COMPONENTS (Continued)

◆ 16.06.03 STEEL RAILING AND POST

Potential defects which may be observed includes corrosion, collision and out of plane distortion.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* Corrosion Railing or Post:			
Observation:			
a. Surface rust no pitting evident.	LF		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	LF		
***{Severity M}			
c. Corrosion evident with loss to base section.	LF		
***{Severity H}			
Defect:			
* Post Connections:			
Observation:			
a. Loose bolts or fasteners.	EA		
***{Severity M}			
b. Broken or missing bolts.	EA		
***{Severity H}			
Defect:			
* Rail Connections:			
Observation:			
a. Loose bolts or fasteners.	EA		
***{Severity M}			
b. Broken or missing bolts.	EA		
***{Severity H}			
Defect:			
* Corrosion at Post Anchors:			
Observation:			
a. Surface rust no pitting evident.	EA		
***{Severity L}			
b. Corrosion evident pitting and blistering of base material.	EA		
***{Severity M}			
c. Corrosion evident with loss to base section.	EA		
***{Severity H}			

16.06 BRIDGE RAILING AND PARAPETS

COMPONENTS (Continued)

◆ **16.06.03 STEEL RAILING AND POST (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Vehicular Damage:**			
Observation:			
a. Railing out of alignment.	LF		
***{Severity M}			
b. Post out of alignment.	LF		
***{Severity M}			
c. Post broken or missing.	LF		
***{Severity H}			
d. Railing broken or missing.	LF		
***{Severity H}			
Defect:			
*** Vertical Joint Displacement:**			
Due to substructure or bearing settlement			
Observation:			
a. Displacement less than 1/4".	EA		
***{Severity L}			
b. Displacement greater than 1/4" less than 1/2".	EA		
***{Severity M}			
c. Displacement greater than 1/2".	EA		
***{Severity H}			
Defect:			
*** Horizontal Joint Alignment:**			
Due to substructure or bearing settlement			
Observation:			
a. Displacement less than 1/4".	EA		
***{Severity L}			
b. Displacement greater than 1/4", less than 1/2".	EA		
***{Severity M}			
c. Displacement greater than 1/2".	EA		
***{Severity H}			

16.06 BRIDGE RAILING AND PARAPETS

REFERENCES

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition.

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.06 BRIDGE RAILING AND PARAPETS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
N/A	

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 16.06.01-1

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: TIMBER RAILING
CONTROL NUMBER: GS-III 16.06.01-1

Application

This guide has been prepared to identify the purpose of a Level III inspection and its more sophisticated test and inspection methods which may be appropriate to determine the cause and/or extent of defects recorded in Level I or Level II defect observations on a timber railing.

Whereas the purpose of the Level I inspection was to record the observable defects on the timber railing, this Level III inspection is performed to provide a thorough systematic evaluation of the observed defect and to make an assessment of it's effects, if left unchecked, on the safety, durability and stability of the railing and it's appurtenant works.

The Level III inspection should be performed when prompted by the results of a Level I or II inspection. The inspection should be performed by an engineer or multidisciplined team of engineers experienced in the design and construction of bridges.

The results of the Level III inspection will be used to develop maintenance or remedial measure work strategy that will correct the existing deficiency conditions or to require continued monitoring of existing deficiency conditions on the bridge railing.

In general, appropriate advanced inspection methods will be identified, recommended, and performed by or under the supervision of the inspection engineer personnel as part of the Level III test and inspection method. Advanced inspection methods will be assigned only after the assessment of defect conditions observed during a Level I or II inspection.

Special Safety Requirements

Passing traffic is a hazard. Level III inspection and testing must be performed with the prior approval of the Facility Manager who will notify the authorities to provide safety measures and safe access.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER RAILING
CONTROL NUMBER: GS-III 16.06.01-1

Inspection Action

1. Prior to making a field inspection of the observed defect, review all past records concerning the deck and the defective component if available. These records may include pre-construction investigation records, design criteria and analysis records, available construction records, previous periodic maintenance inspection records, water level records, and photographs taken during initial construction and subsequent inspections.

2. Perform inspection of the pertinent components where observed defects that triggered a Level III inspection are listed.

3. Make an assessment of the importance of individual defects observed for a given component at the bridge site. Indicate priorities for any required maintenance, or remedial measure work.

4. Identify whether particular observed defects need additional or continued observation.

5. Assess the stability and safety of the bridge railing.

6. Prepare final cost estimate for advanced inspection methods required to determine the cause and extent of the observed defect.

7. Prepare cost estimate for required maintenance or remedial repair measures, as applicable.

Level III advanced inspection methods may be required for specific Level I and Level II defect conditions observed at a bridge site. Level III advanced test or inspection methods and associated observed defects for bridge railing include, but are not limited to the following:

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: TIMBER RAILING
CONTROL NUMBER: GS-III 16.06.01-1

Advanced Test or Inspection Method	Applicable Observed Defects
1. Increment borer	interior and exterior deterioration of timber due to decay or parasites
2. Ultrasonic	interior deterioration
3. Moisture content	deterioration due to decay or parasites
4. Survey measurements	railing movement

Special Instructions

Review as-built and design drawings of structure.

Special Tools & Equipment Requirements

Increment borer
Surveying equipment
Moisture meter

Recommended Inspection Frequency

As triggered by Level I and II defect/observations or every 3 years.

References

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

5. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.07 DRAINAGE

DESCRIPTION

The purpose of a drainage system is to remove water and all hazards associated with it from the structure.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the Standard Tool Section, may be required to perform the inspection of this subsystem.

1. Boat
2. Related safety equipment

SPECIAL SAFETY REQUIREMENTS

Level I and Level II inspections are performed by walking the bridge deck and observing from ground level, thus passing traffic is a hazard. The inspection must be performed with the prior arrangement and approval of the Facility Manager who will notify the necessary authorities so as to provide traffic safety measures and access. Inspector will be required to wear orange safety vest.

Depending on the bridge type, a boat may be required to observe certain components. Inspector will take all necessary safety measures and refer to the Master Safety Plan for guidance and compliance.

COMPONENT LIST

- 16.07.01 DECK DRAIN
- 16.07.02 OUTLET PIPES
- 16.07.03 DOWNSPOUT PIPES
- 16.07.04 DRAINAGE TROUGH

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

19.01	ROADWAYS
20.01	RAILROAD
21.00	WATERFRONT (all subsystems)
29.00	SITE ELECTRICAL (all subsystems)

STANDARD INSPECTION PROCEDURE

The Level I inspection shall be carried out for each component listed. The inspector will identify any physical defects existing in each component; will note the level of severity of each defect type; and measure the quantity of each defect.

16.07 DRAINAGE

COMPONENTS

◆ 16.07.01 DECK DRAIN

The deck drain is a receptacle to receive water and remove it from the deck area. Deck drains may be nothing more than openings in a filled grid deck, holes in concrete deck, or slots in the base of a parapet. Inlet boxes and scuppers are examples of deck drains. Debris is the principal cause of drain inlet clogging. The ponds, or puddles of water, that form on the bridge deck pose the problem of hydroplaning and icing which can cause accidental damage and other extensive bridge deterioration.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Clogging of Inlets:**			
Observation:			
a. Inlet partially clogged.	EA		
***{Severity L}			
b. Inlet totally clogged.	EA		
***{Severity M}			
c. Soil or sand accumulation on deck at inlet.	SF		
***{Severity M}			
Defect:			
*** Deck Drain Grating:**			
Observation:			
a. Cracked grate.	EA		
***{Severity L}			
b. Broken grate.	EA		
***{Severity H}			
c. Missing grate.	EA		
***{Severity H}			

16.07 DRAINAGE

COMPONENTS (Continued)

◆ 16.07.02 OUTLET PIPES

The outlet pipe conducts water away from the deck drain. For bridges over roadways, the outlet pipe connects to a downspout pipe system. When the bridge is not over a roadway, the outlet may simply extend a few feet down from the deck so that drainage is not windblown onto the superstructure.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Deck Outlet Discharge:**			
Observation:			
a. Water stain and/or deterioration of members near outlet discharge.	EA		
***{Severity M}			
b. Water discharge on roadway below.	EA		
***{Severity M}			
c. Ground erosion below deck outlet.	EA		
***{Severity H}			
Defect:			
Pipe Corrosion:			
Observation:			
a. Surface corrosion no pitting evident.	LF		
***{Severity L}			
b. Corrosion evidenced by pitting no blistering.	LF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
***{Severity H}			

16.07 DRAINAGE

COMPONENTS (Continued)

◆ **16.07.02 OUTLET PIPES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damage Outlet Pipe:**			
Deck outlet can be damaged from freezing and collision.			
Observation:			
a. Pipe joint leaking.	EA		
***{Severity L}			
b. Crack in pipe with visible water leakage.	EA		
***{Severity M}			
c. Broken pipe.	EA		
***{Severity H}			
Defect:			
*** Supports and Fasteners:**			
Observation:			
a. Loose supports or fasteners.	EA		
***{Severity L}			
b. Missing supports or fasteners.	EA		
***{Severity H}			
Defect:			
*** Connectors:**			
Observation:			
a. Outlet pipe connection leaks at deck drain.	EA		
***{Severity L}			
b. Outlet pipe disconnected at deck drain.	EA		
***{Severity M}			
c. Outlet pipe connector missing completely.	EA		
***{Severity H}			

16.07 DRAINAGE

COMPONENTS (Continued)

◆ 16.07.03 DOWNSPOUT PIPES

When a bridge is located over a roadway, the deck drainage must be directed from the outlet pipe to a nearby storm sewer system or another appropriate release point. This is done with a downspout pipe network. Downspouts and horizontal runs which have inadequate slope and sharp directional changes are subject to the plugging of drains.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Downspout Discharge:**			
Observation:			
a. Water stain and/or deterioration of members near downspout discharge.	EA		
***{Severity M}			
b. Water discharge from downspout on roadway below.	EA		
***{Severity M}			
c. Ground erosion below downspout outlet.	EA		
***{Severity H}			
Defect:			
Pipe Corrosion:			
Observation:			
a. Surface corrosion no pitting evident.	LF		
***{Severity L}			
b. Corrosion evidenced by pitting no blistering.	LF		
***{Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
***{Severity H}			

16.07 DRAINAGE

COMPONENTS (Continued)

◆ **16.07.03 DOWNSPOUT PIPES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Pipe Slope:**			
Observation:			
a. Pipe slope less than 3/16" per foot, greater than 1/8" per foot	LF		
***{Severity L}			
b. Pipe slope less than 1/8" per foot greater than 1/16" per foot	LF		
***{Severity M}			
c. Pipe slope less than 1/16" per foot	LF		
***{Severity H}			
Defect:			
*** Damaged Pipe:**			
Downspout pipe can be damaged from freezing and exterior forces.			
Observation:			
a. Pipe joint leaking.	EA		
***{Severity L}			
b. Crack in pipe with visible water leakage.	LF		
***{Severity M}			
c. Broken pipe.	LF		
***{Severity H}			
Defect:			
*** Supports and Fasteners:**			
Observation:			
a. Loose supports or fasteners.	EA		
***{Severity L}			
b. Missing supports or fasteners.	EA		
***{Severity H}			

16.07 DRAINAGE

COMPONENTS (Continued)

◆ 16.07.04 DRAINAGE TROUGH

Drainage troughs are located under expansion joints to carry away the deck runoff water which passes through the joint.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Trough:**			
Observation:			
a. Trough shows signs of leaking.	LF		
***{Severity L}			
b. Trough full of rocks and debris.	LF		
***{Severity L}			
c. Trough is cracked or torn.	LF		
***{Severity H}			
d. Trough discharging onto structure.	LF		
***{Severity H}			
e. Trough missing.	LF		
***{Severity H}			
Defect:			
*** Trough Slope:**			
Observation:			
a. Trough slope less than 3/16" per foot greater than 1/8" per foot.	LF		
***{Severity L}			
b. Trough slope less than 1/8" per foot greater than 1/16" per foot.	LF		
***{Severity M}			
c. Trough slope less than 1/16" per foot.	LF		
***{Severity H}			
Defect:			
*** Supports and Fasteners:**			
Observation:			
a. Loose supports or fasteners.	EA		
***{Severity L}			
b. Missing supports or fasteners.	EA		
***{Severity H}			

16.07 DRAINAGE

REFERENCES

1. U.S. Department of transportation, Federal Highway Administration, Bureau of Public roads (DOT) Bridge Inspector's Training Manual, 1990 Edition.

2. Bridge inspection and Rehabilitation, Parsons Brinckerhoff Edited by L.G. Silano, PE, 1993

3. Inspection of Bridges and Trestles NAVFAC MO-126, October 1991

4. ACI Manual of Concrete Practice 1989, Part 1 Materials and General Properties of Concrete

5. AASHTO Manual for Maintenance Inspection of Bridges, American Association of State Highway and Transportation Officials

6. Micro Bridger (Version 1.0), U.S. Army Construction Engineering Research Laboratory

16.07 DRAINAGE

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER

N/A

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER

N/A

APPENDIX A

ABBREVIATIONS

AASTHO	American Association of State Highway and Transportation Officials
ABUT	Abutment
ACI	American Concrete Institute
AGO	Associated General Contractors
ARTBA	American Road and Transportation Builders Association
BRG	Bearing
CONC	Concrete
DIA	Diameter
EA	Each
EFFLOR	Efflorescence
FT	Feet
H	High
IN	Inches
INFILT	Infiltration
L	Low
LF	Linear Feet
LS	Low Severity
M or MED	Medium
MS	Medium Severity
PCS	Pieces
SEVRL	Several
SF	Square Feet
UOM	Unit of Measure
W/	With

APPENDIX A

WKS	Weeks
WT	Water
YR	Year
<	Less Than
>	Greater Than
%	Percent
/	And

APPENDIX B

Glossary

Abutment	A substructure composed of stone, concrete, brick, or timber supporting the end of a single span or the extreme end of a multispan superstructure and, in general, retaining or supporting the approach embankment placed in contact therewith.
Cantilever Abutment	An abutment in which the stem or breast wall is fixed rigidly to the footing. The stem, acting as a cantilever beam transmits the horizontal earth pressure to the footing, which maintains stability by virtue of the dead weight of the abutment and of the soil mass resting on the rear portion, or heel, of the footing.
Gravity Abutment	A heavy abutment with which resist the horizontal earth pressure by its own dead weight.
Aggregate	Inert minerals such as sand, gravel, and crushed stone. The aggregates are divided into two sizes, fine and coarse.
Alligator or Fatigue Cracking	Series of interconnecting cracks caused by failure of the asphalt concrete surface under repeated traffic loading. The cracking initiates at the bottom of the asphalt surface where tensile stress and strain is highest under a wheel load. The cracks propagates to the surface initially as one or more longitudinal parallel cracks. After repeated traffic loading, the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin od an alligator. The pieces are usually less than one foot on the longest side. Alligator cracking occurs only in areas that are subjected to repeated traffic loadings. Therefore, it would not occur over an area unless the entire area was subjected to traffic loading. Alligator cracking does not occur in asphalt overlays on concrete slabs. Alligator cracking is considered a structural distress.
Anchor Bolt	A shaft-like piece of metal commonly threaded and fitted with a nut and washer at one end only, used to secure in a fixed position upon the substructure the bearing of a bridge, the base of a column, a pedestal, shoe or other member of a structure.
Asphalt Bleeding	A film of bituminous material on the pavement surface which creates a shiny, glass-like, reflecting surface that usually become quite sticky. Bleeding is cause by excessive amount of asphalt cement in the mix and/or low air void content. It occurs when asphalt fills the voids of the mix during hot weather and then expands out onto the surface of the pavement. Since the bleeding process is not reversible during cold weather, asphalt will accumulate on the surface.
Approach slab	A reinforced concrete slab placed on the approach embankment to and usually resting upon the abutment back wall. The function of the approach slab is to carry wheel loads on the approaches directly to

APPENDIX B

	the abutment, thereby eliminating any approach roadway misalignment due to approach embankment settlement.
Armor	A secondary steel member installed to protect a vulnerable part of another member, steel angle placed over the edge of a joint.
Backfill	Material placed adjacent to an abutment, pier, retaining wall or other structure or part of a structure to fill the unoccupied portion of the foundation excavation. Soil, usually granular, placed behind and within the abutment and wingwalls.
Backwall	The topmost portion of a abutment above the elevation of the bridge seat, functioning primarily as a retaining wall with a live load surcharge. It may serve also as a support for the extreme end of the bridge deck and the approach slab.
Bearing	A support element transferring loads from superstructure to substructure while permitting movement capability.
Bearing seat	A prepared horizontal surface at or near the top of a substructure unit upon which the bearing are placed.
Bolt	A mechanical fastener with machine threads at one to receive a nut, and a hexagonal head at the other end.
Breastwall	The portion of an abutment between the wings and beneath the bridge seat; the breast wall supports the superstructure loads, and retains the approach fill.
Bridge	A structure spanning and providing passage over river, chasm, road, or the like.
Cantilever	A structural member which has a free end projecting beyond its supporting wall or column, length of span overhanging the support.
Cast-in-place	The act of placing and curing concrete within formwork to construct a concrete element in its final position.
Cement	A powder that hardens when mixed with water, an ingredient used in concrete.
Chord	A generally horizontal member of a truss.
Concrete	A mixture of aggregate, water, and a binder, usually portland cement, which hardens to a stone like mass.

APPENDIX B

Corrosion	The general disintegration and wasting of surface metal or other material through oxidation, decomposition, temperature, and other natural agencies.
Cracking	A crack is a linear fracture in concrete. Cracks may extend partially longitudinal)or completely through the concrete member. On concrete decks and beams, the two basic types of cracks are structural and nonstructural cracks. Structural cracks are caused by dead loads and live loads stresses. Nonstructural cracks are divided into three categories temperature, The wearing surface provides the riding surface for
Curbs	A barrier paralleling the side limit of the roadway to guide the movement of vehicle wheels and safeguard bridge trusses, railing or other constructions existing outside the roadway limit and also pedestrian traffic upon sidewalk from collision with vehicles and their loads.
Dead load	A static load due the weight of the structure itself.
Deck (Structural)	The bridge deck is to provide a roadway over which traffic can move and to distribute traffic and deck weight loads to the superstructure.
Deflection	Elastic movement of a structural member under a load.
Delamination	Delamination occurs when a layer of concrete separates form the bridge deck or beam at or near the level of the outermost layer of reinforcing.
Diaphragm	A member placed within a member or superstructure system to distribute stresses and improve strength and rigidity.
Diver	A specially trained individual who inspects the underwater portion of a bridge substructure and the surrounding channel.
Drainage	A system design to remove water from a structure.
Dye Penetrant	A dye penetrant can be used to define the extent and size of surface flaws in steel members.
Edge Cracking	Cracks parallel to and usually within one to two feet of the outer edge of the pavement. Distress is accelerated by traffic loading and can be caused by frost-weakened base or subgrade near the edge of the pavement. The area between the crack and pavement edge is classified as raveled if it breaks up (sometimes to the extent that pieces are removed).
Efflorescence	Efflorescence is a white deposit on the concrete caused by crystallization of soluble salts (calcium chloride) brought to the surface by moisture in the concrete. Efflorescence is caused by

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	moisture absorption and flow. It is a indication that the concrete is contaminated.
Elastomer	A natural or synthetic rubber-like material.
Erosion	Wearing away of soil by flowing water.
Expansion Joint	A joint designed to provide means for expansion and contraction movement provided by temperature changes, loading or other agencies.
Flange	The horizontal parts of a rolled I-shape beam or of a built-up girder extending transversely across the top and bottom of the web.
Floor system	The complete framework of members supporting the bridge floor and the traffic loading
Footing	The enlarged, lower portion of a substructure, which distributes the structure load with to the earth or to supporting piles. the most common footing is the concrete slab.
Girder	A flexural member which is the main or primary for the support for the structure, and which usually receives loads from floor beam and stringer, any large beam especially if built up.
Ground-Penetrating	This technique uses low-power, high frequency pulsed radar. And important benefit of this method is the ability to measure the thickness of a material.
Guardrail	A safety feature element intended to redirect an errant vehicle away from the approach embankment.
Half Cell Test	This test measures the tendency for corrosion in embedded reinforcing as a display of the electrical potential between two points in steel.
Hairline cracks	Very small cracks that form in the surface of concrete due to tension caused by loading.
Honeycombs	Honeycombs are hollow spaces or voids that may be present within the concrete. Honeycombs are caused by improper vibration during construction, resulting in the segregation of the coarse aggregates from the fine aggregate and cement paste.
Hydroplaning	Loss of contact between a tire and the deck surface when the tire planes or glides on al film of water covering the deck.

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Infrared Thermographic	This Technique uses and infrared camera to detect temperature differentials in a concrete surface. A "cold spot" indicates a delamination.
Inlet	An opening in the floor of a bridge leading to a drain.
Joint	In stone masonry, the space between individual stones; in concrete, a division in continuity of the concrete; in a truss, point at which member of a truss frame are joined.
Longitudinal Bracing	The bracing assemblage engaging the columns of trestle and viaduct bents and towers in perpendicular or slightly inclined planes located lengthwise with the bridge structure and functioning to resist the longitudinal forces resulting from traffic traction and momentum, wind or other forces tending to produce longitudinal movement and deformation.
Magnetic Particle	This test is useful in detecting surface gouges, cracks,and holes. A magnetic field is induced into a member, and cracks or other irregularities in the surface of the member causes irregularities in the magnetic field.
Masonry	A general term applying to abutment, piers, retaining walls, arches and allied structures built of stone, brick or concrete and known correspondingly as stone or concrete masonry.
Member	An individual angle, beam, plate forgiving, casting or built piece, with or without connected parts for joints, intended ultimately to become an integral part of an assembled frame or structure.
Mortar	An intimate mixture, in a plastic condition, of cement, or other cementitious material with fine aggregate and water, used to bed and bind together the quarried stones, bricks or other solid materials composing the major portion of a masonry construction or to produce a plastic coating upon such constructions.
Moisture Content	Moisture meter can be used to determine moisture content in a timber member. Moisture contents exceeding 20% indicate the condition of the wood is conducive to decay.
Outlet	In Hydraulics, the discharge of a drain, sewers, or culverts.
Out-of-Alignment	Bowing, deflection, or other movement that brings the member out of plumb or not level in one or more direction.
Patch Deterioration	Deterioration of an area where the original pavement has been removed and replaced with either similar or different material.

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Parasites	A plant or animal that lies on or within another from which it derives sustenance.
Parapet	A wall-like member composed of brick, stone or reinforced concrete construction upon the retaining portion of an approach cut, embankment or causeway or along the outermost edge of the roadway or the sidewalk portion of a bridge to serve as a protection to vehicular and or pedestrian traffic.
Polished Aggregate	It is caused by repeated traffic applications. when the aggregate in the surface become smooth to the touch, adhesion with vehicle tires is considerably reduced. When the portion of aggregate extending above the surface is small, the pavement texture does not significantly contribute to reducing vehicle speed. Polished aggregate should be counted when close examination reveals that the aggregate extending above concrete is negligible, and the surface aggregate is smooth to the touch. This type of distress is indicated when the number on a skid resistance test is low or has dropped significantly from previous ratings.
Pile Pier or Bent	A pier composed of driven piles capped or decked with a timber grillage or with a reinforced concrete slab forming the bridge seat.
Pile Cap	The top most portion of a pier. On rigid frame piers, the term applies to the beam across the column tops. On hammerhead and tee piers, the cap is a continuous beam.
Pile	A rod or shaft-like linear member of timber, steel, concrete, or composite materials driven into the earth to carry structure loads thru weak strata of soil to those strata capable of supporting such loads. Pile are also used where loss of support due to scour is expected.
Pile Cap	Concrete footing for pier or abutment supported on plies. Also applied to the concrete below the pile tops when footing reinforcing steel is placed completely above the piles.
Pier	A structure composed of stone, concrete, brick, steel or wood and built in a shaft or blocklike form to support the ends of the spans of a multi-span superstructure at intermediate location between its abutments.
Pitting	Development of relatively small cavities in a surface; in concrete, localized disintegration, such as a popout; in steel, localized corrosion evident as minute cavities on the surface.

APPENDIX B

Plate Girder	An I-shaped beam composed of a solid plate web with either flange plates or flange angles bolted, riveted or welded upon its edges. Addition cover plates may be attached to the flanges to provided greater flange area.
Probing	Probing consists of inserting a pointed tool, such as an ice pick, into the wood and comparing its resistance with that of sound wood.
Portal	The clear unobstructed space of a through bridge forming the entrance to the structure.
Pot Holes	Small worm or disintegrated areas of floor or approach surface concaved by the wearing action of vehicle wheels.
Pop-out	Conical fragment broken out of concrete surface. Normally about one inch in diameter. Shattered aggregate particles usually found at bottom of hole.
Primary members	The main load caring members in the superstructure.
Railing	A wooden, concrete or metal fence-like construction built at the side of the roadway, or the sidewalk, upon the retaining wall portion of an approach cut, edge of the roadway or sidewalk portion of a bridge to guard or guide the movement of both pedestrian and vehicular traffic and to prevent the accidental passage of traffic over the side of the structure.
Reflection Cracks	Joint reflection cracking is caused mainly by movement of the PCC slab beneath the asphalt concrete surface because of thermal and moisture changes; it is generally not load-initiated. However, traffic loading may cause a breakdown of the (AC) near the initial crack, resulting in spalling. A knowledge of slab dimensions beneath the (AC) surface will help to identify these cracks.
Reinforced concrete	Concrete with steel reinforcing bars bonded with it to supply increased tensile strength and durability.
Reinforcing Bar (Rebar)	A steel bar, plain or with a deformation surface, which bonds to the concrete and supplies tensile strength to the concrete.
Rutting	A surface depression in the wheel paths. Pavement uplift may occur along the side of the rut; however, in many instances, ruts are noticeable only after a rainfall, when the wheel paths are filled with water. Rutting stem from a permanent deformation in any of the pavement layers or subgrade, usually by consolidation or lateral movement of the materials due to traffic loads. Rutting may be caused by plastic movement in the mix in hot weather or inadequate

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	compaction during construction. Significant rutting can lead to major structural failure of the pavement and hydroplaning potential. Wear of the surface in the wheel paths from studded tires can also cause a type of "rutting".
Scaling	Scaling is the gradual and continuing loss of surface mortar and the aggregate over and area. Scaling is classified as light, medium or severe.
Scour	Erosion of a river bed area caused by stream flow.
Scupper	An opening in the floor portion of a bridge to provide means for rain or other water accumulated upon the roadway surface to drain through it into the space beneath the structure.
Secondary Member	A member that is carried by other members and does not resist traffic load. The function of a secondary member is to brace and stiffen the primary members.
Section loss	Loss of a member cross sectional area usually by corrosion or decay.
Sidewalks	The portion of the bridge floor area serving pedestrian traffic only and, for safety and convenience to its users, commonly elevated above the portion occupied vehicles.
Sole plate	A plate attached to the bottom flange of a beam that distributes the reaction of the bearing to the beam.
Sounding	Determining the depth of water by an echo-sounder or sounding line.
Spalling	A spall is a roughly circular or oval depression in the concrete. Spall results from the separation and removal of a portion of the surface concrete, revealing a fracture roughly parallel to the surface. Spall can caused by corroding reinforcement and friction form thermal movement.
Stiffener	A small member attached to another member to transfer stress and to prevent buckling.
Truss	A jointed structure made up of individual member arranged and connected usually in a triangular pattern, so as to support longer spans.
Warping	A deviation of a member or surface from its original shape, usually caused by either temperature or moisture differential or both within the member.
Web	The portion of a beam located between and connected to the flanges.

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Wearing Surface	The wearing surface provide the riding surface for traffic and is placed on top of the structural deck.
Weathering	The affects caused by light, water and heat. Weathering can change the equilibrium moisture content in the wood, thereby resulting in a change.
Weld	A joint between pieces of metal at faces which have been made plastic by heat or pressure.
Wheel loads	The load carried by and transmitted to the supporting structure by one wheel of a traffic vehicle.
Wingwall	The retaining wall extension of an abutment intending to restrain and hold in place the side slope material of an approach roadway embankment.
Ultrasonic Test	Ultrasonic testing consists of high frequency sound waves introduced by a sending transducer. Discontinuities in the specimen interrupt the sound wave and deflect it toward a receiving transducer.

APPENDIX C

LIFE CYCLES

16 BRIDGES

16.01 ABUTMENTS

Abutments	50 YRS

Source:
AASHTO-AGO-ARTBA Joint Committee
Corrosion Protection of Concrete Components in Bridges
November, 1992

16.02 PILES

Piles	50 YRS

Source:
AASHTO-AGO-ARTBA Joint Committee
Corrosion Protection of Concrete Components in Bridges
November, 1992

16.03 PIERS

Pier	50 YRS

Source:
AASHTO-AGO-ARTBA Joint Committee
Corrosion Protection of Concrete Components in Bridges
November, 1992

16.04 SUPERSTRUCTURE

Superstructure	50 YRS

Source:
AASHTO-AGO-ARTBA Joint Committee
Corrosion Protection of Concrete Components in Bridges
November, 1992

APPENDIX C

LIFE CYCLES

16 BRIDGES (Cont.)

16.05 BRIDGE DECKS

Timber Decks	20 YRS
Concrete Decks	20 YRS
Steel Decks	20 YRS

Source:
Road and Bridge Magazine December 1993
European PCC demo draws AASHTO engineers by Tom Kuennen

16.06 BRIDGE RAILING AND PARAPETS

Timber Railing	20 YRS
Concrete Railing	20 YRS
Steel Railing	20 YRS
Parapet	20 YRS

Source:
Road and Bridge Magazine December 1993

16.07 DRAINAGE

Drainage Device	20 YRS

Source:
Road and Bridge Magazine December 1993